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CONTENTS

	Page
University Education in Central Africa	1007
The Rockefeller Fortune and its Utilization. By L. Farrer-Brown	1009
Dictionary of Chemistry. By R. Brightman	1010
Framework of the Social Sciences. By Prof. T. S. Simey	1010
Metal Fatigue. By Prof. F. C. Thompson	1011
Thermogravimetric Analysis. By Dr. J. R. Nicholls	1011
The Face of the Earth. By Prof. Wilfred Smith	1012
Vistas of Organic Chemistry. By Dr. W. A. Waters, F.R.S.	1012
The World's Transient Energy Resources. By Prof. Frank Debenham, O.B.E.	1013
The National Institute of Oceanography. By Dr. G. E. R. Deacon, F.R.S.	1014
Office of Naval Research Laboratory of Oceanography and Hydraulics Laboratory, Woods Hole, Massachusetts. By Gordon G. Lill	1017
A Link between 'Models' and Living Muscle. By Dr. Arpad Csapo	1019
Obituary: Prof. E. A. Hooton. By Beatrice Blackwood	1022
News and Views	1022
The Dickinson Memorial Lecture	1027
Third International Biometric Conference. By M. J. R. Healy	1027
Gas Absorption: Symposium in Birmingham	1028
Agriculture in Iraq: Completion of Census	1029
Seed Production, Testing and Distribution in European Countries	1030
Immadate Glasses. By E. P. Denton, H. Rawson and J. E. Stanworth	1030
Juvenile Stages of Plants and the Nutritional Status of the Shoot Apex. By A. Allsopp	1032
Inhibition of Mammary Tumours during Lactation induced in Virgin Mice. By Thomas A. Daane, Lowell L. Sparks, Prof. William R. Lyons, Prof. Choh Hao Li, R. David Cole and Tetsuo Hayashida	1035
Letters to the Editors:	
Regularities in the Composition of Pentose Nucleic Acids.—Dr. David Elson and Prof. Erwin Chargaff	1037
Manganese, a Co-factor of Oxidative Phosphorylation.—Olov Lindberg and Lars Ernster	1038
Mitosis and Deoxyribonucleic Acid Content of the Nucleus.—Dr. H. Roels	1039
A Browning Reaction between Thiamine and Glucose.—P. de Lange and L. P. v. d. Mijll Dekker	1040
Lipid Content of 'Standard' and 'Incomplete' Influenza A Virus.—Marianne Uhler and Prof. Sven Gard	1041
Utilization of Topically Applied Methionine by the Guinea Pig.—Dr. L. J. Edwards	1042
Elimination of the Fluorescence of Œstrogens in Urinary Extracts by Hydrogen Peroxide.—C. Heusghem	1043
Action of Ionizing Radiation on Aqueous Solutions of Carbohydrates.—Dr. G. O. Phillips	1044
Spectroscopic Examination of Punicic Acid.—N. H. E. Ahlers, A. C. Dennison and L. A. O'Neill	1045
Nature of the Catalyst in the Decomposition of Carbon Monoxide in Presence of Iron.—Dr. B. Chatterjee and P. P. Das	1046
The Monosubstituted Pteridines.—Prof. Adrien Albert	1046
Early Arrivals in Seismic Prospecting.—Dr. F. F. Evison	1047
Photomicrography with a Kellner Eyepiece.—Dr. Frank Smithson	1047
Bursting of Bubbles at an Air–Water Interface.—D. C. Blanchard; Prof. D. M. Newitt, F.R.S.	1048
Light Absorption in the Crystalline Lens of the Cat.—R. A. Weale	1049
Bacteriophage and Heredity.—Dr. J. S. K. Boyd, O.B.E., F.R.S.	1050
Different-sized Infective Particles of Rift Valley Fever Virus.—W. du T. Naudé, T. Madsen and Dr. A. Polson	1051
Control of Cockchafer Grubs by Seed Treatment.—Dr. S. A. J. Tarr	1052
Recent Scientific and Technical Books	Supp. viii

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UNIVERSITY EDUCATION IN CENTRAL AFRICA

ON July 4, 1953, in discussing university education in Central Africa (*Nature*, **172**, 1; 1953), attention was directed to the difficulties that beset the fusion of the aims of the Carr-Saunders Commission on Higher Education for Africans in Central Africa, and those of the founders of the Rhodesian University. The latter had been instituted in 1946 and, by the time the Carr-Saunders report was published in May 1953, had already obtained a site of 250 acres within the City of Salisbury, Southern Rhodesia. Here the Queen Mother laid a foundation stone during her visit to Central Africa last year.

It would be most unfortunate for money and energy to be dissipated in Central Africa by an attempt to found two separate universities. It would be equally undesirable that the Rhodesia University should curtail in advance its hopes of expansion because of an insufficiency of both land and capital finance. It was hoped that a firm statement by the British Government on the conditions under which it would provide financial support for a University College for Central Africa would clarify the position, and might enable the sponsors of the Rhodesia University scheme to associate themselves with the more ambitious plan put forward in the Carr-Saunders report. The many problems inherent in such a development have now apparently been solved, and an important statement about the plans of the Rhodesian University College at Salisbury, Southern Rhodesia, where university education will be provided for members of all races, has been made by the inaugural board of the Rhodesian University, with the agreement of the British Government and of all the Governments in the Federation of Rhodesia and Nyasaland. The steps by which this solution has been attained are in many ways characteristic of the sometimes slow but nevertheless effective manner in which administrative developments come about within the British Commonwealth.

In its report, the Carr-Saunders Commission visualized the possibility that the College for the Higher Education of Central Africans with which it was mainly concerned should in fact be the Rhodesia University, provided that the sponsors of the Rhodesia University incorporated in their plans elements which it deemed essential, namely, (1) that the University should be multi-racial; (2) that it should be autonomous; and (3) that it should be capable of expansion to the desirable extent by being placed on a site of at least 1,280 acres. Since the Legislative Assembly of Southern Rhodesia had passed, in 1952, an Act entitled "The University Charter and Inaugural Board (Private Act)" which made clear the statutory dependence of the Rhodesia University on the Southern Rhodesia Government, while a site of 250 acres had already been acquired, in a European residential area of Salisbury, Southern Rhodesia, which was not capable of any great expansion, some of the provisions of the Carr-Saunders report were indeed difficult to meet.

Nevertheless, after the report had been published, the inaugural board of the Rhodesia University declared that the University would be inter-racial and that admission would be solely dependent on the educational attainments and the good character of the applicants.

The Carr-Saunders report had recommended that a capital grant of £1¼ million should be acquired for the institution of the proposed University College and that application should be made to the Colonial Development and Welfare Fund for this sum. But of course the acquisition of such a grant by the Rhodesia University would depend not only on the adoption of a satisfactory racial policy but also upon approval of the site of the College, and of its charter.

As was pointed out in the article in *Nature* of July 4, one of the territories concerned, namely, Southern Rhodesia, is a self-governing Colony and administratively associated with the Commonwealth Relations Office in London, whereas Northern Rhodesia and Nyasaland, both Protectorates, come under the Colonial Office; in such circumstances the two government offices might easily fail to come to an agreement concerning responsibility for the capital grant. The first step towards the solution of this problem would appear to have been a statement by the Secretary of State for Commonwealth Relations that in matters concerning university education in Central Africa he would consult and be advised by the Inter-University Council for Higher Education in the Colonies, and that he would welcome a visit by a delegation from the Rhodesias and Nyasaland to discuss the whole question of the new university. In September last a delegation from Central Africa arrived in Great Britain, headed by Mr. E. C. F. Whitehead, lately Southern Rhodesian Minister of Finance, and including Mr. L. M. N. Hodson, Deputy Speaker for the Southern Rhodesian Legislative Assembly and chairman of the Rhodesia University Inaugural Board. The delegation was representative of the inaugural board of the Rhodesia University, of Southern and Northern Rhodesia, and of Nyasaland. During its visit the delegation had discussions with the Inter-University Council, with officials of the University of London, and with representatives of Her Majesty's Government. The delegation described its plans for a university college in Salisbury, which would be a centre of learning and research and provide university education for students of all races, and sought the advice of university authorities in the United Kingdom on a number of subjects. The Inter-University Council warmly welcomed and endorsed in principle the plans of the inaugural board of the Rhodesia University, subject to certain amendments which were discussed in the course of the talks. Her Majesty's Government then announced its preparedness to make a grant of £1¼ million from Colonial Development and Welfare Funds under certain conditions. The provision of this grant was briefly noted in the press at the conclusion of the delegation's visit (see *Nature*, October 10, p. 654). It was then stated that the proposed university college (a first step to a full university) would seek to enter into a special relationship with the University of London. The statement also referred to conditions regarding the adequacy of the site, the autonomy of the administering body, and the provision of recurrent expenditure from other sources.

Since then, the appointment of a principal of the Rhodesia University College has been announced. He is Dr. W. Rollo, formerly professor of classics in the University of Cape Town, and he took up his duties early this year. He visited Great Britain in February last, having talks with the Inter-University Council, and with representatives of the University of London, among others.

The University College is to be built on the Mount Pleasant site in Salisbury, Southern Rhodesia, the site which the Carr-Saunders Commission regarded as inadequate in size. But the city of Salisbury has granted to the inaugural board additional land adjacent to the original site, so that the total area on which the College is to be placed will be 450 acres. In addition, the College will be given facilities for teaching and research in the proposed Botanical Gardens, near the University site, and also at the Veterinary Research Station, and land can be given to the College for a farm of an extent about 1,000 acres, to be devoted to teaching and experimental work, in a suitable area to be made available for that purpose. In addition, the needs of a medical school will be met by the provision of sufficient land on the site of 250 acres on which the new Salisbury Native Hospital has recently been erected. The Medical School will thus be separated from the main University by a distance of some miles; but this is not an unusual arrangement. A basic principle in the planning of the University will be the absence of discrimination on racial grounds between categories of students, and halls of residence for African students will be placed at a distance no greater from the centre of the University than those for Europeans.

Southern Rhodesian Parliamentary authority will be sought for the amendment of the Act of 1952 under which the inaugural board of the Rhodesia University was set up, and a new constitution is under consideration which will ensure that the University has complete freedom from Government control or interference. A greater degree of academic representation on the governing body than was intended under the Act will thus be provided. The proposed constitution of the College will ensure its complete autonomy, and it is intended that Her Majesty the Queen shall be asked to grant a Royal Charter for the incorporation of the University.

The inaugural board has applied to the University of London for the admission of the Rhodesia University College into special relationship with the University of London, and the Senate of the University has agreed to accept the application, subject to the receipt of satisfactory information with respect to the constitution and proposed development of the College. This means that, when the special relationship has been established, the degrees awarded to successful students of the Rhodesia University College will at first be those of the University of London. The courses will be based on

syllabuses adapted to local opportunities and needs, devised in consultation between the College itself and the authorities of the University of London. Faculties of Arts and Science will first be established, and the Principal of the College has already discussed with officers of the University of London the requirements for the admission of students to the College in general and to these Faculties in particular. After these basic faculties have been established, Faculties of Agriculture and Medicine will be inaugurated. Ultimately, of course, the special relationship with the University of London will be terminated, and the university college, having become a full university, will give its own degrees.

For the first phase of the College's development an estimated minimum sum of £2 million will be needed for capital expenditure on buildings, equipment, apparatus, library and furniture. The Federal Government of Rhodesia and Nyasaland understands that in the next few years the College will be unable to meet more than a small proportion of the necessary recurrent expenditure, and it has indicated its willingness to present annual estimates to the Federal Parliament on this basis. The Federal Government therefore expects to meet almost the whole of the recurrent expenditure in each of the initial years. A minimum of two years will be needed for the initial building, equipment and staffing; but it is hoped that the College will in fact be open for teaching by March 1956.

The agreed proposals are in some respects a compromise between the recommendations of the Carr-Saunders Commission and the original plans of the inaugural board of the Rhodesia University; but it is of such importance that an agreed solution be found at the present time for the problems involved in the provision of higher education in Central Africa, that a compromise along these lines will be accepted by all reasonable people. All those interested in higher education and its development within the British Commonwealth will welcome the energy and decision that have gone to the attainment of the present position, and those in Great Britain will wish to send their greetings and encouragement to their friends in Central Africa whose labours promise such a rich reward.

THE ROCKEFELLER FORTUNE AND ITS UTILIZATION

Study in Power

John D. Rockefeller, Industrialist and Philanthropist. By Allan Nevins. Vol. 1: Pp. xvii+441+7 plates. Vol. 2: Pp. xi+501+7 plates. (New York and London: Charles Scribner's Sons, 1953.) 2 volumes £3 3*s*. net.

THIS book is a new version of Prof. Allan Nevins's earlier biography published in 1941 and entitled "John D. Rockefeller: The Heroic Age of American Enterprise". Prof. Nevins regards it as in great degree a new book, because, while preserving all the essential data of its predecessor, it "contains a large amount of hitherto unknown and highly illuminating material". In the intervening years he has had access to an immense body of letters, and he has been able to learn more about Mr. Rockefeller's benefactions and of the men who helped him with them. This new material has enabled Prof. Nevins to give greater definition to his subject without increase in length. Indeed, there has been a considerable shortening in the text. Even so, the repetition of some statements, while to some extent justified in a work of such length, gives birth to the passing wish that the process of condensation had been carried further than it has; but this wish quickly passes as the story reasserts its grip. For it is a story that engrosses the attention. Scholarship and readability have been commendably wedded; the prose is crisp and workmanlike, well suited to the subject.

The 'power' which Prof. Nevins has set out to study is Mr. Rockefeller's organizing power, applied first to industry and then to philanthropy. In the preface he claims that his study is "emphatically a biography, not a history". Shall we say with Emerson, there is properly no history, only biography? It is truer, perhaps, to suggest that in the greater part of the present work (which deals with Mr. Rockefeller as an industrialist) biography and history coalesce. The biography of Mr. Rockefeller is at the same time a history of the oil industry in the United States and especially of the dominant Standard Oil Combination. This part of the book might be described as the history of a trade war and a study of the generalship of Mr. Rockefeller and his associates. It was a war of many campaigns, bitterly fought within the United States—between oil producers and refiners, between the refiners themselves, with the railways and the pipe-line companies—and no less bitterly contested overseas for European, Asiatic and Latin-American markets. ". . . although few histories mention the great Russo–American war of 1885–1914 in oil, that conflict raged relentlessly", between Standard Oil on one side and on the other the Baku refiners, led by the gifted Nobel brothers, and the Rothschilds' Anglo–Caucasian Co.

Offensive and defensive strategies were carefully planned; weapons at times were ruthlessly employed; some of the tactics are censurable under current codes, though, perhaps, in part excusable in the light of the practices of the time. The outcome, as in other industries in which similar battles were fought, was the sweeping transformation of an industry from a conglomeration of small, financially weak, bitterly competitive units to a concentration of highly organized power. This long process, which involved much destruction and reconstruction, Prof. Nevins describes and analyses vividly and justly.

Mr. Rockefeller is portrayed as a cool, subtle strategist with an unemotional, analytical mind. He justified his strategy in the oil industry on the ground that only by combination could efficiency and economy be achieved; and in pushing his aim to the achievement of an almost complete monopoly —vertically integrating the industry from well-head to the consumers of multiple oil products—he maintained, despite forty years of obloquy, that he had acted for the public good. The vast fortunes of the stockholders is sufficient evidence that this strategy yielded high profits. It is to be regretted that Prof. Nevins has not been able to deal more fully with the trend of prices to consumers or with labour's share in the fruits of efficiency. In a one-page appendix on Standard's labour policy, he does little more than state that "material on the company's labour relations

is scanty" and that "all observers are agreed" that Rockefeller insisted upon good wages and kindly treatment, that labour troubles were rare and that unions were discouraged.

No small part of Mr. Rockefeller's strength seems to have been his ability to select and retain highly gifted associates both in his business affairs and in the task of giving away five hundred million dollars. Almost all were men of strong and independent minds, who accepted Mr. Rockefeller as *primus inter pares* rather than as their despotic head. Appropriately, much of Prof. Nevins's study is concerned with these men. His treatment of the parts they played and of their personalities and achievements throws much light on Mr. Rockefeller's own qualities and his place in history. Even so, despite all that has been written by others and despite the illumination which Prof. Nevins has himself given, he is, probably, right to entitle his final chapter (in which he seeks conclusions on these questions) "Trial Balance", instead of "Epilogue", as in the earlier biography.

L. Farrer-Brown

DICTIONARY OF CHEMISTRY

The Van Nostrand Chemist's Dictionary

Edited by Prof. Jurgen M. Honig, Dr. Morris B. Jacobs, Prof. S. Z. Lewin, William R. Minrath, and Dr. George Murphy. Pp. iv+762. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 60*s*. net.

THE decision what to exclude or include can never be easy for the compilers of any specialized dictionary; without a clear conception of the users for whom the dictionary is intended, the task may be well-nigh impossible. This dictionary is well produced and printed, and it appears to be notably free from misprints—that of "Levenstein" for "Levinstein" is one of the very few which have been noted. Nevertheless, it is not easy to judge from the internal evidence exactly for whom this book is intended. The exclusion of all trade names, even those in the field of plastics and synthetic fibres coming into general use as generic terms, whether justifiable or not, severely limits its use for the technical or industrial chemist, who will find Bennett's "Concise Chemical and Technical Dictionary" more useful. The term 'rayon', for example, is omitted, and even the scientific or academic chemist might well look for definitions of the meaning of some such terms. There appears, moreover, to be no clear idea in the mind of the compilers as to what a chemist is likely to look for in such a dictionary as distinct, for example, from Lange's "Handbook of Chemistry" or "Atack's Chemists' Yearbook". So far as the British reader is concerned, American spelling and the American outlook, evident, for example, in the article on chemical nomenclature, quite as much as the high price, will tend to discourage its use. Whether a chemist would expect to find these articles in the dictionary may be a matter of opinion. He might at least have expected to find something more than a reprint or digest which ignores all contributions other than from American sources. Further, if nomenclature is introduced, why only six pages on chemical nomenclature in general, but twelve on carbohydrate nomenclature and none on other special aspects, such as that of co-ordination compounds, hydrogen isotopes, fluorine and phosphorus compounds?

A feature of the book is the large number of reactions and tests which are included under proper names. More than five thousand entries of this kind are claimed. For reactions, however, the book is less comprehensive than Wheeler and Adams's "Name Index" and, moreover, the latter has the advantage of references. The absence of references and almost complete absence of dates is a feature of this dictionary which from one point of view detracts considerably from its value. A few of the definitions appear shaky or inadequate, notably those of 'alembic', 'coupling' and 'antioxidant'. There is also a certain lack of balance: for example, the term 'cinnoline' is not defined, but 'cinnamate', 'cinnamic', 'cinnamoyl' and 'cinnamyl' are all elaborated.

Apart from the rather dubious omission of practically all terms verging on the category of a trade name, even where they may well be of interest to the academic chemist, omissions such as 'magneto chemistry', 'Raney–Nickel catalyst', 'fluorocarbon' and 'hydrogenolysis' are to be noted, as well as that of the antibiotics from penicillin onwards or medicinals such as 'cortisone', 'prontosil' and the like.

The layout of the dictionary is clear and even lavish. There would appear to be plenty of room for compression in this respect. Careful editing of such articles as those on benzene formulæ, the nomenclature of benzene substitution products, and some of the rather inexplicable entries multiplied under such prefixes as 'chloro-', 'phosphoro-' and 'thio-', etc., might well have reduced the size of the dictionary sufficiently for it to be produced at a price within the limits which a chemist in non-dollar countries could reasonably be expected to pay.

R. Brightman

FRAMEWORK OF THE SOCIAL SCIENCES

The Tools of Social Science

By John Madge. Pp. x+308. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 25*s*. net.

THIS is a very valuable book; but it will be a difficult one for the student or the general reader. It is, in fact, two books in one. Its objective is to provide an account of the methods which the social scientist has developed during the past hundred years in the prosecution of social researches; but the author has found it impossible to confine himself to a mere description of methods, as such. The dilemma in which he has found himself is that the conceptual framework within which the social sciences have grown is by no means secure. There are serious gaps in it, and, to pursue the analogy further, parts of the structure are in a state of severe tension. Since the conceptual framework is so inadequate, the secondary or methodological system associated with it is hard to describe; it is still harder to evaluate it. The author has therefore found himself, quite consciously, trying to write a book on the logic of the social sciences and another on their methods at one and the same time.

The parts of the book dealing with logic are so good that one can only hope that when Mr. Madge produces the second edition of his work he will display the courage of his convictions, and re-write it as a treatise entirely devoted to a critical analysis of the

conceptual framework of the social sciences. Compared with his more philosophical studies, his chapters dealing with such matters as observation and the interview are trite and inconclusive. At no stage in his argument is he able to provide a satisfactory appraisal of techniques of measurement, of "action research" or "participant observation", because he finds himself compelled to return over and over again to the discussion of the primary question of the objectives of the social scientist, and the differences between the natural and the social sciences. It is on this note that the book begins and ends, and it is because Mr. Madge has faced problems of such great importance fairly and squarely that it is so stimulating. It is for this reason that it will be found to be a very valuable teaching text, as well as a most useful compendium of information.

The best things in the book are an excellent discussion (if a rather one-sided one) of the 'objectivity' of the social scientist, which leads to the forthright conclusion that "in no science is the pursuit of objective knowledge more futile than in social science". Mr. Madge's treatment at the end of the book of the problem of experimentation in the social sciences is also provocative, though it is less carefully argued. Here again, his conclusions are highly controversial, for he argues that "on this basis the social sciences are not yet adult".

Mr. Madge's work demands a public reply from the social scientists who disagree with him. It is to be hoped that it will force them to face fundamental issues such as these more openly than has been their habit hitherto.

T. S. Simey

METAL FATIGUE

Fatigue of Metals

By R. Cazaud. Translated by A. J. Fenner. Pp. xiv+334+19 plates. (London: Chapman and Hall, Ltd., 1953.) 60*s*. net.

"THE extent of the literature on the characteristics and behaviours of metals, when subjected to cyclic stresses, is so great as to present a real difficulty even to that specialized circle of engineers and scientists who must, for professional reasons, keep themselves closely informed of progress in knowledge, thought, experience and technical application in this field. The publication of a comprehensive survey of the subject, prepared by one who has made extensive personal research contributions to current knowledge, is, therefore, a welcome and notable event: the present book, by Dr. Cazaud, can, indeed, be thus described." Coming from Dr. H. J. Gough in his foreword to this volume, this is high praise, but it is eminently deserved. The book may be divided roughly into two, more or less equal, parts; the first is concerned with fatigue in general, its explanation and measurement, and the second is devoted to a consideration of those aspects of the subject of more direct importance to the engineer.

It is of interest to note how markedly this book differs from earlier ones on the subject in the extent to which the real nature of fatigue, and its effect on the structure of a metal, are gradually becoming clearer. It is evident that the explanations offered are still in some measure speculative, but an approach to a rational and fundamental explanation is now within sight.

To me, however, it was the second and more practical part of the book which seemed to be of such outstanding interest. An enormous amount of factual material is collected, and this is then interpreted, and interpreted with great success, in terms of direct utility to the engineer-designer. The long concluding chapter which is concerned with the improvement of the fatigue strength of machine components, in particular, is a fine piece of work.

In addition to the very large number of diagrams, there are many photographs, the standard of which is high, and all of which show clearly the point with which the author is concerned. Corrosion fatigue, as well as that under normal stressing, comes in for considerable consideration, and there is a mass of references to all branches of the subject. Further experimental data will no doubt come to light, but the fact that much new material published since the appearance of the French edition in 1948 has been incorporated means that all major contributions up to the present time are included.

This book is a translation from the French version by Mr. A. J. Fenner, and the highest praise is due to him for the manner in which it is presented: there is little, if anything, to suggest that it is a translation at all. It is not too much to say that this volume represents the best discussion of the whole problem which has yet appeared, and should for years to come be the authoritative work.

F. C. Thompson

THERMOGRAVIMETRIC ANALYSIS

Inorganic Thermogravimetric Analysis

By Clément Duval. Pp. xv+531. (Amsterdam and New York: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1953.) 60*s*.

GRAVIMETRIC analysis finally depends upon weighing a residue and making a calculation based on its presumed nature. In most instances the residue has been heated with the object of removing water, destroying organic matter and leaving the presumed substance. The presumption of composition of the residue is based on previous work which has followed the gain or loss of weight of the heated residue as a function of time and temperature. Often this can be done effectively by a few empirical tests; but it may be desirable to have a full picture of the behaviour of the residue over a wide practical range of time and temperature.

Thermogravimetric analysis involves weighing a heated substance while still at a definite temperature, and its immediate objective is the determination of pyrolysis curves of heated substances. By means of a specially constructed thermobalance, one arm of which is within a furnace where the temperature can be regularly raised, a material can be weighed at all stages of time and temperature, and the changes in weight recorded continuously and automatically, either photographically or by pen. A pyrolysis curve is thus obtained which indicates the ranges of temperature between which the weight of the material is constant or is increasing or decreasing.

Once a fundamental pyrolysis curve has been obtained, it can immediately be inferred whether the substance is suitable for a gravimetric finish and, if so, the particular temperature to which it must be heated to ensure constancy of weight. This book describes the technique and records the pyrolysis curves, between 20° and 1,000° C. (for substances

which do not explode previously), of nearly a thousand precipitates which are used or have been proposed to be used for inorganic gravimetric analysis. Most of these curves have previously been published; but it is convenient for all to be collected together.

A thermobalance is particularly adapted for obtaining a complete pyrolysis curve, but it can also be used with a furnace maintained at a constant temperature. A precipitate which is known from a previously determined curve to attain constant weight at that temperature can be placed on the arm of the balance in the furnace and its weight noted as soon as the recorder shows that no change is occurring. No time need be lost in cooling to room temperature before weighing. A further application is to the gravimetric analysis of certain mixtures. For example, a mixture of calcium and magnesium oxalates (such as might be obtained by precipitating calcium from a solution containing much magnesium) can be weighed after heating at 500° C. ($CaCO_3$ + MgO) and again at 900° C. (CaO + MgO). The amount of each metal in the precipitate can then be calculated.

It is not every laboratory that could use economically a thermobalance; but some might find the time saved well worth the expense. All could benefit by applying the information given by pyrolysis curves obtained with this relatively new technique to the ordinary operations of gravimetric analysis.

J. R. Nicholls

THE FACE OF THE EARTH

The Skin of the Earth

By Prof. Austin Miller. Pp. ix+198. (London: Methuen and Co., Ltd., 1953.) 21*s*. net.

SEVERAL books on the geographical employment and interpretation of the map have recently appeared. To the geographer the map is not merely an instrument for finding one's way from place to place, but is much more a record of the face of the earth the character of which can be discerned by those who have the skill to read and understand. This skill has two fundamental ingredients. The first is familiarity with the map itself and with the ground the features of which it records. A geographer must be intimate with both the actual landscape and the map, which is a drawing of that landscape as shapely to the geographer as plan and elevation to the architect and as portrait to the painter. The second ingredient is experimental technique in extracting from the map all that it can tell us, and to this end the geographer practises laboratory methods of isolating each element in turn for examination.

Prof. Austin Miller has written "The Skin of the Earth" in order to develop precisely these skills. His object is not simply map literacy but map understanding. It is based on the experience of twenty-five years of experiment and of teaching. Many of the techniques employed are either his own invention or have been sharpened by his hands. Some have appeared previously in research papers, but they are here arranged in sequence to form a coherent exposition of methods of analysis. It is not only the techniques themselves which attract the reader, but also the way in which they are presented to expound Prof. Miller's conception of the subject. The introductory chapter is a finely written essay in this field. The argument is that map analysis consists, first, of the dissection of the anatomy of the landscape, limb by limb and nerve by nerve, and, second, of the elucidation of the physiology of the skin of the earth, "its temperature, its moisture, and the circulation of air and water in it and upon it". But time and time again Prof. Miller insists that dissection of each element considered singly is not enough and that the objective of the geographer is the recognition of the full orchestral symphony of the landscape. With the humanized landscape, however, he does not attempt to deal. "Human geography begins where this book ends."

In the reviewer's opinion the section entitled "Topographical Anatomy" is the more immediately successful. The treatment of the "Circulatory Systems" is at once more difficult, for it involves rapidly moving elements which cannot be measured so readily as the geomorphologist's physical landscape, and less documented, for the evidence arises out of instrumental observations which present but a coarse network. Nevertheless, in this second part of the book as in the first there is a whole armoury of tools. The great merit of the book is that it challenges the reader to experiment for himself, to devise more and more refined methods of map dissection and of cartographical experimentation, so that the whole structure and function of the skin of the earth shall be laid bare.

Wilfred Smith

VISTAS OF ORGANIC CHEMISTRY

Progress in Organic Chemistry

Vol. 2. Edited by Prof. J. W. Cook. (Progress Series.) Pp. viii+212. (London: Butterworths Scientific Publications, 1953.) 42*s*. net.

VOL. 2 of the series "Progress in Organic Chemistry" is, like its predecessor (reviewed in *Nature* 170, 993; 1952), a very mixed assortment of articles some being gallant but wholly inadequate attempts to survey topics of wide scope, and others concise but satisfying accounts of subjects of much more limited range. Since no topic has even a remote connexion with those of Vol. 1, it is evident that the editor has decided to show how diverse can be the interests of the present generation of organic chemists; in future volumes he will, we hope, lead us to still fresh fields and pastures new.

Faced with such an assortment of topics, most readers will come to the individual chapters for general information, welcoming a lucid exposition above all else. Judged in this light, the first chapter, by M. J. S. Dewar, on recent developments in theoretical organic chemistry, is the least satisfactory. Symbolism is unavoidable in dealing with wave-mechanics, but it is surely unnecessary to pack the text with jargon such as "the NBMO of an AH". Since it seems that organic chemists now must be presented with mathematical equations prefaced by "it can be shown that", they do, at the end, wish to discover the extent to which there can now be traced a quantitative correlation between computations and experimental measurements. Unfortunately, one finds as the conclusion: "The experimental data do not yet enable one to judge the quantitative value of such calculations in most cases; but the results seem promising". Are they?

Following this, M. Stacey's chapter on organic fluorine compounds surveys far too much in far too few words, but is simple and most informative to

any student. It ends with a well-chosen summary which brings the organic chemistry of fluorine into its proper perspective. D. H. R. Barton, who has summarized the chemistry of the triterpenoids in thirty-six pages, usefully charts interrelationships of compounds of the α- and β-amyrin, lupeol and lanosterol series and then confines his attention to topics of major structural significance. The chapter is admirable for reference but difficult to read and appreciate immediately.

In contrast, F. S. Spring's following chapter on the partial synthesis of cortisone is a precise but adequate essay on a much more restricted topic. It brings welcome clarity to a subject that is almost unreadably technical in the original literature, and makes sufficient use of clear structural formulæ to reveal to the reader at a glance both the mechanism and the stereochemistry of every reaction that it discusses. H. H. Inhoffen's chapter on relationships between natural steroids and carcinogenic compounds is again an adequate essay which collects facts new and old so as to give most readers a stimulating perspective of the wider significance of research in pure organic chemistry.

Finally, J. P. Wibaut, in reviewing pyridine chemistry in but forty pages, has again been forced to select topics from an immense subject. As would be expected from such an experienced teacher and writer, he has chosen his material in the interest of students. After exemplifying recent investigations of the structure and reactions of pyridine compounds, he finally devotes a few pages to pyridine alkaloids, pyridoxine and codecarboxylase. The whole chapter is excellent but far too short.

No organic chemist can put down this book without being conscious of the excellence of the printing. Clear, exact graphical formulæ are the prime requisite in any volume which deals with the complexities of modern researches in organic chemistry. Here they are presented with meticulous neatness and accompanied by typescript of adequate size. For this both the editor and the publisher deserve the highest praise.

W. A. WATERS

THE WORLD'S TRANSIENT ENERGY RESOURCES

Energy in the Future

By Palmer Cosslett Putnam. Pp. x+556+17 plates. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 90*s*. net.

AS implied in its title, this book is a study of an increasingly vital problem looming larger before the eyes of the world with every passing year. Mr. P. C. Putnam is an eminent engineer who has, for many years, been at the heart of research and development in the field of energy, in which he has had a distinguished career both in peace and in war. His book is the outcome, or digest, of a report made by him to the Atomic Energy Commission, and the scope of the inquiry is prodigious yet logical enough.

It begins with an attempt to assess the future world population, a necessary premise, since it is the population that uses up the energy. The first quarter of the book, therefore, concerns the value of predictions of the population of the world in A.D. 2050; and, deciding that it is unpredictable, it assumes a figure for which the author uses the word 'plausible', where others, perhaps, would prefer the term 'reasonable'. (The converse, 'implausible', will scarcely commend itself to our ears.)

A large number of tables and graphs contribute to the plausible figure arrived at, which presents the somewhat grim picture of 3,700 million in A.D. 2000 and no less than 6,300 million in A.D. 2050. Mr. Putnam has to omit possible factors, such as world disasters by plague and famine and world wars, since these are even more unpredictable than birth-rates and longevity. The figure seems to be all too reasonable, though some will think that the author is too optimistic over the rate of advance he expects among the backward peoples. He seems to accept a rather rapid transition from what he calls the illiterate subsistence farming pattern of peoples to the literate industrial–urban–farm pattern.

The author, rightly despairing of any great accuracy in the figure, asks his reader to picture an imaginary prudent "Trustee of Energy" who will do his best to equate the growth of population with the energy available to give it a reasonable standard of living. The remaining three-quarters of the book is therefore devoted to a study of all the resources of energy, actual and potential, and the figures arrived at are just as grim as those for population. The study is very comprehensive and thorough, and accompanied by a wealth of tables and graphs. As was to be expected, the energy derived from capital resources of fuel is shown to be disappearing at an alarming rate. What the author graphically calls the "burn-up" of the fossil fuels (coal, oil and natural gas) is going on so fast that their end is measurable in a few score years at most in the main industrial countries. He has to relate the resources of these fuels still available to the cost of their recovery, and he accepts a reasonable ceiling for these costs at twice the 1950 costs.

Mr. Putnam then passes to "income" energy, including such diverse sources as wood-fuel, water-power, wind-power and the energy potentially available from photosynthesis. As a first-rate engineer, he endeavours to reduce all these to plausible figures. From solar heat-collectors, for example, he manages to collect quite a respectable amount of energy, though he applies it mostly to what he calls "comfort energy", house heating, etc. Taken as a whole, however, the total of income energy is disappointing, and our benevolent and prudent Trustee can only find 12 per cent of the energy we need for the next century from that source, so he turns to the new field of nuclear fuels. The figures here are admittedly rather speculative, and, of course, nuclear energy is like coal—in the category of capital, a wasting asset. He reaches the conclusion that in A.D. 2050 the energy system of the world will comprise 15 per cent from income sources and 85 per cent from capital, of which nuclear fuels will have to provide 60 per cent.

Copious notes fill the latter half of the book, and in these (appendixes, as we should call them) there is a good deal of material which might well have deserved a place in the body of the book. This is particularly true of some thirty pages on the food situation of the future, and it is on this topic, curiously enough, that one meets a heartening conclusion: "Techniques within man's grasp could provide food, clothing and shelter for a world population many times the size of the present".

The book carries a warning to all and perhaps most clearly to the United States itself, that, in the words of the Trustee, it cannot continue to live at a high standard off its energy resources.

FRANK DEBENHAM

THE NATIONAL INSTITUTE OF OCEANOGRAPHY

By Dr. G. E. R. DEACON, F.R.S.

AN outline of the history and aims of the National Institute of Oceanography was given in *Nature* of March 17, 1951. The Institute has now been housed in its own premises for more than a year, and is fairly well established. The new laboratory is on Wormley Hill, near Witley Station, half-way to the coast on the main line from London to Portsmouth. The building was erected as part of an Admiralty research establishment in 1943 on a corner of the estate of King Edward's School, Witley; it is now rented from the Admiralty with the goodwill of the Bridewell Trust, which agreed to lease the site for the Institute's work. The building measures 180 ft. by 40 ft. and has four stories. Inside there are large well-lit working spaces for marine physics, biology, chemistry and other aspects of oceanography, a fairly spacious library, dark-rooms, drawing office, laboratory workshop, machine shop, carpenter's shop, storage space, kitchen and dining room. There are additional spaces in outbuildings for storage, battery-charging, sand-blasting and paint-spraying.

The advantages of such a building lying in a very pleasant and accessible position might be lessened by the fact that it is sited 350 ft. above the sea and 35 miles inland; but since the Institute's work needs mainly deep water and recording apparatus installed on widely separated parts of the coast, the objection is not serious. On the contrary, with such a wide range of subjects to be covered, there are advantages in being near London. The transport of equipment by road to the ship is not difficult, and often cheaper than bringing the ship back to the home port, and it is not a bad idea to treat each cruise as a small expedition: the staff whose turn it is to go to sea take good care that the apparatus works, and they probably find it easier to get on with the work when they are detached from their homes and headquarters.

The annual report of the National Oceanographic Council for 1952–53 shows that some £22,000 had been spent on adapting and equipping the new building, and about half as much again has been used for completing the work in 1953–54; but the impression now given to visitors is one of a laboratory well suited for the immediate objects and for expansion.

The main emphasis of the Institute is on long-term research, but plenty of scope is allowed for work on immediate practical problems which have a useful bearing on oceanography and keep the staff in touch with other laboratories and potential applications of their work. Assistance is given to authorities concerned with marine aspects of defence research, and to those responsible for regulation of the whaling industry, and help and advice are given to many others. One of the most frequent ways in which help is given is in the analysis of complex records, for which the equipment developed for analysis of wave records is particularly suitable. Facilities for making observations in deep water are afforded to research workers from universities and other laboratories. The Institute has already an extensive and up-to-date library covering most aspects of oceanography, and deals regularly with a wide variety of requests for information.

The principal items on the Institute's own research programme are all aimed at increasing our under-

Fig. 1. National Institute of Oceanography, Wormley

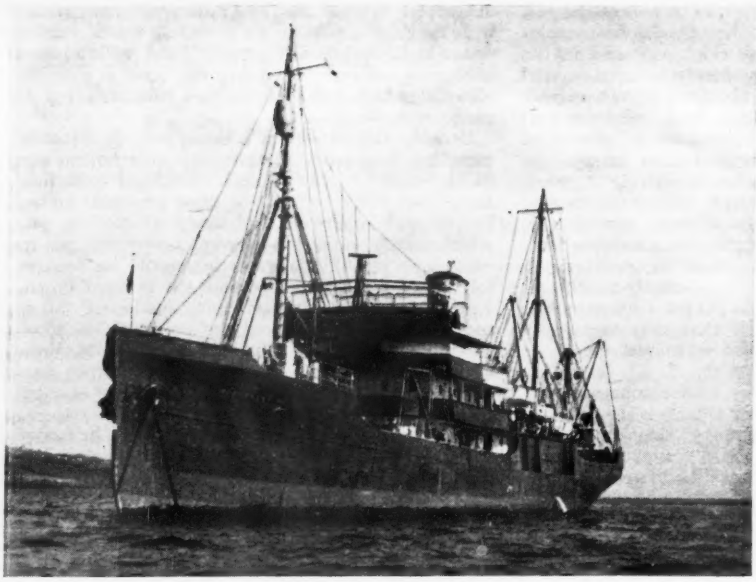

Fig. 2. R.R.S. *Discovery II*

standing of the basic physical, biological and chemical processes in the oceans, so that present and future problems can be approached more intelligently than at present.

Research Programmes

Interchange of energy between atmosphere and oceans. Statistical estimates of the transport of heat from one part of the ocean to another are being based on the data collected by the Marine Division of the Meteorological Office from selected ships. The transfer of momentum from the wind to the sea is being studied from measurements of changes in direction and velocity of the wind near the sea surface, and measurements of the transfer of energy and momentum across a water surface are being made on the King George VI Reservoir and at sea.

Response of the sea surface. Wave recorders have been developed for most purposes, together with the apparatus for analysing the records, so that the development of the wave pattern can be treated realistically as the growth of a wave spectrum. By using shore-based wave recorders and selecting well-defined storms at varying distances, methods have been devised for predicting the wave spectrum in the storm area and at the coast. The work is now being extended to deep water (well away from the coast, tidal streams and other disturbing factors) with the help of routine wave recordings by ship-borne wave recorders installed in the Ocean Weather Ship *Weather Explorer* and R.R.S. *Discovery II*. Theoretical and experimental studies are also being made. A theoretical and practical study has been made of the relation between microseismic oscillations and waves, and a start has been made on an investigation of the sources of energy responsible for exciting the natural oscillations in coastal waters and 'range action' in harbours.

Wind drift is being studied with the help of continuous records of the varying e.m.f. between the English and French coasts due to varying flow of water through the Strait of Dover, and with continuous records of the daily magnitude and direction of the flow of water past light-ships around the British coast. Figures are also being obtained from the recovery of drift-cards put out in the ocean west of the British Isles.

Wind-driven and thermodynamic circulation in the oceans. In view of the importance of a detailed understanding of the principal surface currents and deep-water movements to all aspects of oceanographic and fishery research, the study of oceanic water movements is intended to have first place in the Institute's programme of research in marine physics; but progress is slow because of theoretical and practical difficulties, and because the subject depends on most of the other research items. While progress is being made with the preliminary studies, apparatus has been designed to measure the deep-water movements. One of the methods will use a pattern of sono-radio buoys to follow the path of a slowly-sinking acoustic transmitter; another will use a current meter towed in the deep layers by a very long cable to measure the relative speed of surface and deep movements. Arrangements have also been made for three-dimensional measurements of velocity close to the sea bottom to study the effect of friction for different water speeds and density profiles; this must be done in fairly shallow water.

Free and forced oscillations in the oceans. The velocities due to tides and internal waves must be taken into account in studies of deep-water movements, and a start has been made with the development of apparatus for measuring small pressure changes in deep water. Attempts are also being made to find a practical method of making continuous records of the oscillations of 'density layers' in the ocean.

Factors governing the distribution of marine organisms. The biological activities of the Institute have been founded on the work of the Discovery Committee, which regarded oceanographic work as an essential part of research on whales and built up an exceptionally rich and well-documented collection of oceanic plankton and other marine life. It is excellent material for studies of the distribution of marine plants and animals in relation to their environment, and adequate for the initial testing of any general conclusion about the effect of environmental factors on the movements and distribution of oceanic species. The key to the distribution of a number of pelagic organisms has already been found in the division of different stages in the life-history between surface and deeper-water masses and currents, and further investigations into such processes are being pursued.

Taxonomic and faunistic work. The collections can be roughly divided into the plankton samples obtained from standard nets which are used in the special studies of distribution already referred to, and the more general collections obtained from a variety of tow-nets, trawls, dredges and miscellaneous sources. The Discovery Committee's system of sorting these general collections into groups for examination by specialists is being actively pursued, and the Institute is indebted to many workers who are preparing, or who have already contributed, papers for the Discovery Reports. Contributions from such specialists, who work either in museums or other institutions or privately, are mostly taxonomic reports. Many of them are based on very extensive material, and it is fair to say that they make substantial contributions to what is known of life in the sea.

Productivity of ocean waters. Of comparable importance to the variety of life in the sea is the quantity of life and the rate of organic production. Much work in the field has aimed at a comparison of the wealth of the fauna and flora in different regions, and at relating the distribution of whales and plankton to the physical and chemical patterns. Observations were made over wide oceanic areas, in all latitudes from the Antarctic to the tropics, characterized by marked features or contrasts in fertility, and they provide data not only on variations from place to place but also at different times of year. In the analysis of such material good progress is being made towards the definition and explanation of normal distribution of, and regular variations in, the quantities of organisms; and work is being pursued into principles which should help to explain the less regular and long-period fluctuation, and to confirm other tentative conclusions.

Whale research. The main purpose is to study the bionomics of whales, and one of the principal objects is to acquire knowledge for the sustained and efficient exploitation of whales. Just as fisheries research is dependent on the oceanography of the fishing grounds, whale research is dependent on studies of the oceanic plankton, of the variations in oceanic productivity, and of the distribution of physical and chemical variables in the water, especially because the work is largely concerned with distribution, migrations and movements of the population of whales. Much effort is devoted also to anatomical and physiological studies of reproduction, growth and age, which in turn must be examined in relation to distributions and migrations, and the statistics of catches. The ultimate aim is prediction: to be able to make reasonably accurate estimates of where, when and in what quantities whales will be found, what will be the effect of hunting them at one time and place or another, and in what degree the populations will be able to replace their losses or recover from depletion.

New methods. The staff of the Institute includes workers with experience in most aspects of oceanography, and enthusiasm to apply them to practical problems. The methods and techniques developed cover a wide range of interests: for example, a fisherman wanting to know something about subsurface currents would not use apparatus unless it was simple, cheap and required no maintenance; but a research worker does not mind how elaborate the mechanism or electronic circuit is, provided he can obtain a continuous record down to very low velocities. Both types of instrument have been developed in the Institute; they include a fairly wide range of apparatus for recording waves, currents, water-level and beach profiles, and techniques for analysing and correlating records. Most of them have already been proved useful, and suitable for a wide range of applications.

Considerable attention is being paid to methods of sampling deep-sea animals which may be too active to be caught in towed nets. Detailed experiments have been made to find the most practical voltages, length and repetition frequency of electric pulses which might be used to prevent active animals from escaping a net. Underwater television has been tried for examining the water and sea bottom down to 1,000 ft. Experiments are being made with an echo sounder using a balanced transmitter and receiver which remain in the vertical as the ship rolls. Various adaptations of long lines, traps and other fishing methods for securing oceanic animals are also being tested.

Movements of sand and beach material. The Institute has inherited an interest in the factors which influence the growth and changes in offshore bars and harbour approaches, and affect landing operations on a beach. Much of the apparatus for recording wave height, oscillatory water velocities, wave reflexion, and small changes in ground profiles in shallow water and on the beaches has been developed; but the systematic approach to the problem has been delayed by the theoretical difficulties and prior claims of work involved in setting up the new laboratories and other projects. There are many demands for more precise information about the processes which influence coastal erosion and, although the problems belong to the field of hydraulic engineering rather than marine physics, the scientist whose work lies offshore can help to solve them.

Further details of the Institute's work are described in the annual reports of the National Oceanographic Council issued each year since 1949–50, and in its first volume of Collected Reprints issued in March 1954 and Discovery Reports which have been published from time to time as completed.

Many authorities have helped the Institute on to its feet and now, as in the past, the work owes much to the interest and support of the Superintendent of the Admiralty Research Laboratory and the Director and Trustees of the British Museum (Natural History), where the bulk of the Discovery Collections is still housed. Many zoologists, some of them on the staff of the Museum, have devoted much time to groups from these collections, and contributed to the Discovery Reports. The Chief Engineer, Post Office Engineering Section, has afforded much help in the study of the effect of wind on tidal streams, and the Elder Brethren of Trinity House have been very co-operative in allowing measurements to be made from light-ships. The Marine Division of the Meteorological Office has been most helpful in providing marine meteorological data and wave records taken every three hours while the *Weather Explorer* is at sea. The R.A.F. has given invaluable help in the study of drift currents in the eastern North Atlantic Ocean. Finally, the Institute is indebted to a number of whaling companies of several nationalities which have given indispensable help in the collection of material and generous facilities for the marking of whales, and to ships which have forwarded reports of the sighting of whales.

OFFICE OF NAVAL RESEARCH LABORATORY OF OCEANOGRAPHY AND HYDRAULICS LABORATORY, WOODS HOLE, MASSACHUSETTS

By GORDON G. LILL

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BY June of this year the Bureau of Yards and Docks of the United States Navy will have completed the construction of a new Laboratory of Oceanography and Hydraulics Laboratory in the village of Woods Hole, Massachusetts. Work at the Laboratory will be conducted under the control and sponsorship of the Office of Naval Research, although it is expected that oceanographical research of a general character will be carried out at the new laboratory.

The reasons for locating the new laboratories in Woods Hole are simple but of significance when one thinks of the most profitable means of fostering research. Woods Hole is unique on the Atlantic coast as a scientific community devoted to oceanic studies. The Marine Biological Laboratory, the Woods Hole Oceanographic Institution, and the U.S. Fish and Wildlife Service Laboratory, through the high quality of their research, have created a scientific atmosphere that will quickly stimulate the activities at a new laboratory and keep them alive. One of the world's most nearly complete oceanographical libraries has been collected jointly by this group and is located in the Marine Biological Laboratory, where it is used by all. Research vessels and dock facilities are available in addition to a complete and modern assemblage of oceanographical instruments. In the face of these qualifications, which are not duplicated elsewhere, Woods Hole could not be excelled as the site for the new laboratories.

The primary reason, of course, for constructing the laboratories is to assist in meeting the increasing requirement of the U.S. Navy for oceanographical information. However, justification of this sort cannot be divorced from others which are of more importance to the general scientific welfare. For example, the Woods Hole Oceanographic Institution has contracted with the Navy to perform marine research for many years. As a result of meeting the requirements of the Navy, the administration of the Institution has limited the use of its facilities by private scientists who desire on occasion to work there. A situation of this sort is obviously detrimental and should be at least partially alleviated by the new laboratories. The Marine Biological Laboratory also performs contract research for the Navy, and the Fish and Wildlife Service has long co-operated with the Navy on many research problems. It is likely that these two activities will find the new facilities to be of benefit as well. It is difficult to specify the research work at Woods Hole by agencies or laboratories. From the point of view of the Office of Naval

Fig. 1. Three sites, *A*, *B*, *C*, at Woods Hole, considered for the Laboratory of Oceanography; site *A* was chosen. The Marine Biological Laboratory is at the left; Woods Hole Oceanographical Institution is left centre; Eel Pond is in the background

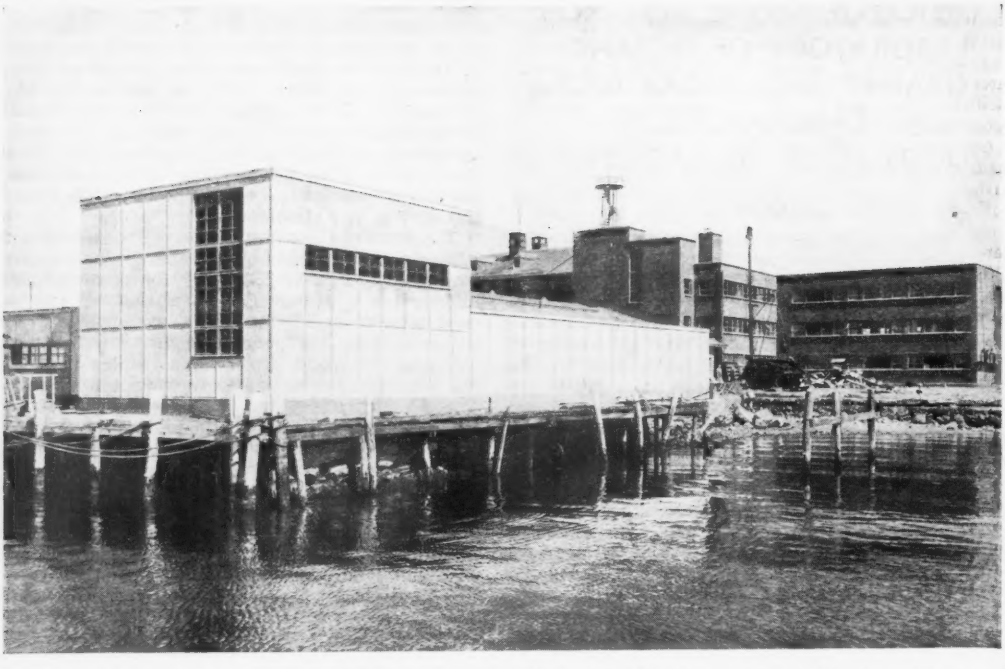

Fig. 2. Hydraulics Laboratory and, in the background, the main building of the Office of Naval Research Laboratory of Oceanography

Research the laboratories of the village must be considered as a scientific group, although at times through military necessity they may give the impression of partiality to one or another particular science. Here again we find a situation that can, and probably will, be eased.

In constructing the Laboratory of Oceanography advantage was taken of the machine shop already on the premises. The construction also includes an inexpensive, but adequate, Hydraulics Laboratory. Both buildings are mentioned in the following quotation taken from the Bureau of Yards and Docks Specifications:

"*General Description*. The unit at the front of the site shall be a three story structure in front and one story in the rear, the latter part being an existing building to be altered and extended. There will be no basement. Construction will be a concrete foundation with steel frame above, concrete slab floors and roof with exterior walls of brick and concrete blocks.

"The unit at the rear of the site (Hydraulics Laboratory) shall be a wood framed building with walls and roof of insulating board on concrete foundation."

On the first floor of the Laboratory of Oceanography and to the left of the entrance lobby are two large conference rooms, and beyond these are several private offices and an underwater acoustics laboratory, plus a small photographic dark-room. A corridor from the lobby to the rear of the building leads to the shop and to storage areas which will be devoted to instrument repair, instrument development, instrument storage, the machine shop, carpenter shop, stock room, laboratory services room, boiler and generator rooms, lavatories, and locker rooms. It should be noted that the underwater acoustics shop has been electrically insulated from the others by copper wire mesh completely surrounding the room.

Roughly one-half of the second floor is reserved for the instrument development section. The remainder will be utilized for drafting, multilithing, opaquing and photographic work. To the rear of the building, over the shop spaces, are located various storage rooms.

The third floor has been largely set aside for the hydrographic laboratory group. There are also a general research laboratory and a small room.

An instrument tower some 25–30 ft. in height is located on the roof of the building. The tower will be equipped with meteorological instruments. The roof itself is flat and can be used for out-of-doors research when desired.

The spaces briefly described in the foregoing encompass about 28,000 sq. ft., which nearly duplicates the area of the Oceanographic Institution.

The smaller of the two buildings, the Hydraulics Laboratory, will contain a flume 100 ft. long by 4 ft. deep by 4 ft. wide. To one side of the flume will be a circular tank 2 ft. deep by 20 ft. in diameter. This building also has a small balcony office and a shop for welding and other metal-work.

A few characteristics of the Laboratory of Oceanography which are of particular interest may be mentioned. The building is completely water- and fireproof. The floors are constructed of preformed, prestressed concrete blocks which, where covered with asphalt tile, will have a 'dusted off' finish and where exposed will be given a hardening treatment with a water solution of magnesium-fluosilicate crystals. In the laboratories and corridors the ceilings will be covered by acoustic tiling. Movable

partitions of pressed or rolled steel will be installed throughout. Electrical, gas, fresh- and salt-water, and compressed-air outlets are fixed at regular intervals, so that if partitions are rearranged these facilities will always be accessible. A hydraulic lift, operated by oil, and 6 ft. by 9 ft. in dimensions with a net lifting capacity of 5,000 lb., will be centrally installed. The laboratories and shops will be fitted with 115 volt d.c. and 440 volt a.c. 3-phase electrical outlets. An engine-generator for emergency lighting and oil-burning equipment will be installed in the generating room.

The construction of the two buildings is being carried out by the C. Sullivan Company, Inc., of Newport, Rhode Island, under contract with the Bureau of Yards and Docks. The architect was Mr. Gunnar Peterson, of Falmouth, Massachusetts. The resident officer in charge of construction is Lieutenant Robert P. Lathrop (C.E.C.), U.S.N.R.

The building will be ready for occupation by about June 1. A dedication ceremony is planned by the Navy for June 21, to be followed by a three-day oceanographical convocation on many of the important phases of the marine sciences. Scientists from Britain, Denmark, The Netherlands, Norway, Sweden and the United States will participate in the proceedings of the convocation, which will be sponsored co-operatively by the scientific community at Woods Hole, the National Research Council of the National Academy of Sciences, and the Office of Naval Research. The papers presented at the meeting will be published in one volume by the National Academy.

The research accomplishments of the scientists at Woods Hole have resulted in world-wide fame for the village. The Office of Naval Research anticipates with pleasure the opportunity of assisting in the scientific effort of the community.

A LINK BETWEEN 'MODELS' AND LIVING MUSCLE

By Dr. ARPAD CSAPO

Department of Embryology, Carnegie Institution of Washington, Baltimore, Md.

IT is concluded from experiments on muscle 'models' that the final reaction of muscular contraction is an interreaction between actomyosin and adenosine triphosphate in the presence of ions[1,2]. If the delicate architecture of the actomyosin particles is preserved, as in glycerol-treated psoas muscle, the model develops about the same tension as it does in the living condition. This model can also relax after an isometric contraction if creatin phosphate and 'adenosine triphosphate–creatine transphosphorylase', which are removed by glycerol treatment, are replaced[3,4]. When activated by adenosine triphosphate, it shows the well-known changes in the elastic modulus, characteristic of active living muscle (ref. 2, quoted in ref. 1).

A well-recognized difference exists, however, between the behaviour of the models and that of living muscle. The former develop maximum tension in isotonic potassium chloride, whereas living muscle becomes 'inexcitable' in this condition, developing practically no tension upon the application of an otherwise optimum stimulus. Inexcitability is explained by the disappearance of the electrochemical gradients[5].

It is of interest to know whether in living muscle, in the absence of these gradients, the final contractile system retains its maximum capacity for the development of tension. Experiments to be reported here indicate that maximum tension can be repeatedly obtained in living muscle in the absence of both potassium and sodium gradients, and thus the processes of activation and isometric contraction can be separated experimentally. Such maximum activation of an 'inexcitable' living muscle, in the absence of the gradients, can be produced by an electrical stimulus (essentially a longitudinal field produced in the perfusion bath between two platinum ring electrodes) five times stronger than required for maximum tension when the gradients are present. This stimulus does not lead to irreversible changes in the living muscle.

Œstrogen-dominated[6] rabbit uteri were used. In previous experiments this tissue was found to maintain its high-energy phosphate stores *in vitro* (in the presence of 100 mgm. per cent glucose) for several hours. It also maintained the capacity to develop maximum tension for a period of seven days if it was stored between tests at + 4° C. in a mammalian Krebs's solution in which five-sixths of the sodium chloride was replaced by isotonic glucose. One can assume, therefore, that within the two hours duration of the present experiments the contractile system was unaltered. The fact that the myometrium has been used in these experiments does not imply that other muscles do not have the same or similar properties.

Segments of the tubular uterine horn about 40 mm. long (at resting length), about 5 mm. in outside diameter, and with muscle walls about 1 mm. thick, were mounted on platinum hooks, in a 13-ml. bath of mammalian Krebs's solution, between two platinum ring electrodes. The rings were 12 mm. in diameter, 65 mm. apart. Temperature was kept constant at 37·5° C. and the *p*H at 7·4 by oxygenating the Krebs's solution with 95 per cent oxygen + 5 per cent carbon dioxide (for material and techniques see ref. 6). For electrical stimulation alternating current (60 cycles) rather than direct current was used, for reasons discussed elsewhere[7]. The duration of the a.c. stimulus and the time-interval between two subsequent stimuli were kept constant at the optima (5 sec. and 1 min., respectively) and only the field-

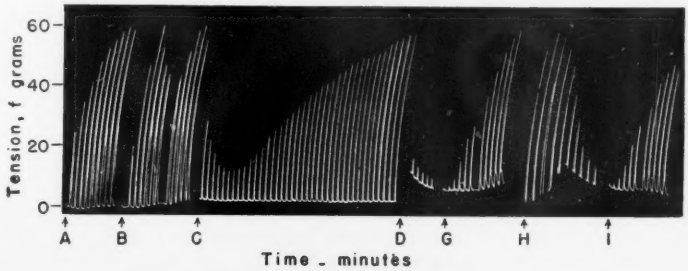

Fig. 1

strength (E, volts/cm.) was altered in altering the stimulus.

A typical record, taken from a series of more than fifty runs, is shown in Fig. 1. In order to have an absolute scale of tension (f) the same segment was used in all steps. The segment was quickly removed from the anæsthetized animal ('Nembutal', 40 mgm./kgm.) and placed in the experimental tube in mammalian Krebs's solution. It was kept unstimulated for 10 min. in order to reach resting steady state. At (A) stimulation was begun with E = 0·154 V./cm. No tension developed, indicating that the stimulus was subthreshold. One minute later, E = 0·308 V./cm. was applied with consequent development of tension. Thereafter E was increased, by 0·308 V./cm., at intervals of 1 min. Maximum tension was obtained at E = 2·46 V./cm. At E = 2·77 V./cm. tension began to decrease.

After the 'strength–tension' relation had been established, on a previously unstimulated uterine segment (A), the same relation was observed in the same sample, after it had been exposed to experiment (A). Record (B) shows the relation. The previous threshold value (E = 0·308 V./cm.) was found insufficient to cause development of tension; the threshold had increased after procedure (A) to a value of 0·77 V./cm. Afterwards, E was increased by this latter value in regular steps. As in the previous run (A), maximum tension was recorded at E = 2·31 V./cm., and thereafter tension decreased up to E = 4·62 V./cm. After this stimulus, E was increased in steps of 1·54 V./cm. (beginning where indicated by the interruption in (B)). A second rise in tension was observed with a second maximum tension at E = 10·08 V./cm. Upon further increasing E, the tension again decreased. It should be noted that the maximum tension was obtained at two distinctly different values of E, namely, 2·3 and 10·08 V./cm. These values will be referred to as 'first-peak' and 'second-peak' stimuli, respectively.

To indicate that the second-peak stimulus resulted in no irreversible changes in the contractile system, the recovery after the application of this stimulus was observed. The record shows (C) that the effectiveness of the first-peak stimulus (applied repeatedly once a minute) gradually returned, and maximum tension was obtained after a period of about 30 min. In the next step the gradients were eliminated by the use of a specially prepared salt solution, and the effect of this procedure on the strength–tension relation was observed. Taking Horvath's[8] values into account for intracellular concentrations of potassium and sodium ions in the œstrogen-dominated uterus, the concentration of sodium ions was decreased in the mammalian Krebs's solution from 144 mM to 25 mM, and the difference of 119 mM was replaced by potassium chloride. Thus the final concentration of potassium ions was 125 mM, whereas that of sodium ions was 25 mM. The buffer system was left unaltered.

At point (D) on Fig. 1, when the muscle had recovered from the second-peak stimulus (as indicated by the reappearance of maximum tension in response to first-peak stimuli), ordinary Krebs's solution was replaced by the solution described above. Stimulation continued once every minute with first-peak stimulus as before, and the effect of the eliminated gradients revealed itself by an immediate drop in tension. It should be noted that the uterus was in moderate contracture, and also that tension was not zero. In a steady state the experiment described at (B) was repeated (G) by increasing E in the same manner. The first peak disappeared and tension increased gradually with increasing E. The fact that the first-peak stimulus was not completely ineffective in this condition will be discussed later.

Fig. 2

Next, the relation between the abolition of the first peak (in a system uniformly stimulated in a field) and the disappearance of the potassium gradient or of the sodium gradient, respectively, was studied. After recovery from the second-peak stimulation (not shown) the sample was tested again in a bath in which only the concentration of potassium ions was gradually increased (with a simultaneous increase in ionic strength up to 262 mM). The first-peak stimulus was used for testing, and the concentration of potassium ions was increased by 12-mM steps (H). The muscle was stimulated once every minute as before, but the tension was recorded only at 2-min. intervals, the intervening time being used for changing the concentration of potassium ions. The final concentration of potassium ions in the bath was 124 mM; tension decreased gradually as the concentration was increased. When repeating the experiments as illustrated at (B) and at (G), the same general picture was obtained (I) except that each respective tension was somewhat less.

Further experiments (not shown on the graph) demonstrated that this relative reduction in tension was not due to the presence of the sodium gradient or to hypertonicity as such, but to the increased concentration of the monovalent cations (potassium + sodium) which directly alters the contractile system. By increasing the concentration of sodium ions in the same way as that of potassium ions was increased before, both peaks decreased to the same extent as the second peak did before, the position and shape of the peaks being unaltered (as compared to (B)). On the other hand, increasing the molarity with isotonic glucose up to 262 mM did not alter the maximum tension at all.

To summarize the results, Fig. 2 was plotted from Fig. 1, (A), (B) and (G). The heavy lines are experimental, the broken ones hypothetical. The dotted line indicates the tension-level elicited by intrinsic stimuli of fluctuating quantity. The line with crosses shows the level of contracture when the electrochemical gradients are eliminated.

Curve (*b*) shows the two distinct peaks characteristic of the strength–tension relation of uterine muscle. The first ascending limb of (*b*) is shifted to the left in the presence of effective intrinsic stimuli (*a*). This indicates that in the fresh uterus, not electrically stimulated, the intrinsic stimulus and the applied electrical current are additive and result in more tension than can be accounted for by the electrical stimulus itself. The intrinsic stimulus of the myometrium is not a constant quantity but fluctuates as it builds up and breaks down, resulting in fluctuating spontaneous tension around the threshold value. Its origin is not known. Comparing (*a*) and the first ascending limb of (*b*), one can see that the effect of the intrinsic stimuli gradually lessens as *E* approaches the first-peak value, and is completely absent at the climax. If we use the term 'inhibition' in describing the effect of increasing current on the intrinsic stimuli, we may conclude that this inhibition results in a transient disappearance of spontaneous activity and an increase in the threshold for electrical stimulation, and that the first-peak stimulus is a constant quantity whether or not the sample was previously stimulated.

If we assume, as a working hypothesis, that the first-peak stimulus becomes effective by utilizing the potential energy of the electrochemical gradients, and moreover that during the physiological process of activation this potential energy is somehow utilized, then the first descending limb of (*b*) indicates a gradual inhibition of this activation as the current strength increases. The extrapolated value suggests that this inhibition is complete at the second-peak stimulus. With the techniques at present applied, however, this descending limb can be only partly obtained, because of the second rise in tension, which is called here the second peak. Since this peak is essentially unaltered if the gradients are abolished, an alternative pathway of activation is indicated which is effective without the participation of the ionic gradients. In this working hypothesis, it is assumed that a current five times stronger than the first-peak stimulus activates the contractile system directly. The position of the second peak without the gradients is represented by (*g*). The slight shift of (*g*) to the left in the presence of the gradients (second ascending limb of (*b*)) might be explained by a summation of direct activation of the contractile system plus the incompletely inhibited activation through the membrane mechanism.

These experiments indicate that the contractile system may be activated in different ways. A relatively well-defined stimulus, such as the electrical field, might lead to complete 'excitation' and at the same time 'inhibition' of a more highly organized alternative pathway of excitation. (Classification of pharmacological agents according to their 'excitatory' or 'inhibitory' effects on the myometrium appears unattainable since the effects would depend on their concentration and on the physico-chemical state of the target system rather than on the chemical structure of the active substance.)

The extrapolated lines at the tops of the peaks indicate inhibition of both activation mechanisms to an increasing extent as the optima are approached. This in turn suggests that the potential maximum tension of living muscle is never obtained experimentally. Studies of the length–tension relation of the excised living uterus led to the conclusion[7] that "increasing stimulus alters the dynamics of contraction in such a way that there is inhibition of tension development at higher tensions". The experiments reported here rather indicate that at the first peak it is not the process of contraction which is inhibited by increasing the strength of stimulation, but that the process of activation is inhibited as the alternative pathway becomes increasingly effective.

In agreement with the conclusion drawn from the models, the present experiments indicate that in living muscle the gradients are not needed for the process of isometric contraction itself, but are required for the normal process of activation. The process of activation can be separated experimentally from that of the contraction cycle by using the second-peak stimulus, which seems to by-pass and inhibit physiological activation, or by using this stimulus in the absence of the gradients.

The final contractile system in living muscle, as in the models, requires for maximum effect only a proper concentration of monovalent cations (potassium + sodium). Between 154–262 m*M*, it is not sensitive to hypertonicity as such.

By the separation of the two basic processes of muscle function, activation and contraction, some interesting features of living muscle can be approached. The dependence on temperature of tension of mammalian (rabbit) myometrium splits into two distinct curves when studied at the first- and at the second-peak stimulus. This indicates that what has been studied so far is the dependence of activation on temperature, and that the curve describing this dependence for contraction is shifted towards the left, simulating the position of the curves characteristic of living frog sartorius muscle and those of glycerol-treated rabbit psoas muscle[1]. This suggests that in different species the process of activation is more likely to depend on temperature than is the contraction cycle.

The characteristic phenomena of the uterus, namely, 'positive' and 'negative' staircases[9] under œstrogen and progesterone domination respectively, are absent at the second-peak stimulus, indicating that these phenomena are related to the process of activation rather than of contraction.

Substances like oxytocin, adrenaline, acetylcholine and histamine, which decrease the threshold of stimulation of the œstrogen-dominated uterus, become ineffective (reversibly) in the absence of the gradients. Their effect is linked to the process of excitation. Since the system described allows observations on the process of isometric contraction in living muscle in the presence and absence of physiological excitation alternately, this model is offered as a link between glycerol-treated and living muscle. In the sense of a first approximation, this model may be useful in learning whether a certain muscle disorder involves alterations in the process of activation or that of contraction.

I am grateful to Dr. B. Horvath for suggestions on the experimental approach, and to Drs. G. W. Corner, F. Brink and K. L. Zierler for the benefit of discussions.

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OBITUARY

Prof. E. A. Hooton

By the sudden death of Ernest Albert Hooton, until lately professor of anthropology at Harvard University, anthropology has lost one of its most brilliant, provocative and stimulating exponents. He died on May 3, at the age of sixty-six, as the result of a heart attack shortly after returning from lecturing in the Department to which so many years of his life had been devoted, and where he still enjoyed teaching, though he had retired from administrative responsibilities.

Hooton was born in Wisconsin, and attended Lawrence College and the University of Wisconsin. In 1910 he went to Oxford as a Rhodes Scholar, intending to read classics. Instead, he studied anthropology under R. R. Marett, Arthur Thomson and Henry Balfour, being awarded the diploma with distinction in 1912. Although it was in the field of physical anthropology that he made his mark, he never underrated the importance of the other two sides of the subject, as taught by that famous triumvirate. It was characteristic of him that he dedicated one of his books "To the most social of social anthropologists, to the most human of human anatomists, to the most advanced interpreter of primitive industries, in short, to my teachers of anthropology at Oxford". He returned to the United States to take up the post of instructor in the then infant Department of Anthropology in Harvard University, where he remained to become, in 1930, professor of anthropology and head of the rapidly expanding Department.

His first major publications were detailed anthropometric studies of two large collections of human bones, "The Ancient Inhabitants of the Canary Islands" (1925) and "The Indians of Pecos Pueblo" (1930); the latter, a masterly analysis of the skeletal remains of a thousand years of occupation of that New Mexican village, added much to our knowledge of the physical characteristics of the American Indians. Meantime, the wider problems of physical anthropology were claiming his attention, and his later work was devoted to interpreting man's place in Nature, physical and psychological, past, present and future, in terms which those who were not anthropologists could understand. To arouse interest in a subject which Hooton considered of major importance to everybody, the titles of his books grew more and more startling: "Up from the Ape" (1931) was followed by "Apes, Men and Morons" (1937), "Why Men behave like Apes and Vice Versa" (1940) and "Man's Poor Relations" (1942). His unconventional, witty and often pungent style caused his books to become widely known, and if his unorthodox approach sometimes shocked his staider colleagues, they had to admit that behind his showmanship he had the root of the matter in him.

In addition to writing, teaching and building up his Department, Hooton put his unfailing energy and powers of organization at the service of those who were striving to promote the study of anthropology elsewhere, while his kindly interest and trenchant advice were always available to individual students of the younger generation. His too early loss will be deeply regretted by all who had the privilege of knowing him.

Beatrice Blackwood

NEWS and VIEWS

Principal of the Rhodesia University College: Dr. W. Rollo

Dr. W. Rollo has been appointed the principal of the new Rhodesia University College, the development of which is discussed on p. 1007. Dr. Rollo, who was formerly professor of classics in the University of Cape Town, took up his position early this year. He was educated at the University of Glasgow, where he graduated before the First World War, and in Holland. During that War he was captured by the Germans and eventually permitted to go to Holland in an exchange of prisoners arranged between Great Britain and Germany. During his time in Holland he studied at a Dutch university and took a degree, while teaching English and classics to Dutch students. His wife is Dutch, and after the War he moved to South Africa, where ultimately he became professor of classics in the University of Cape Town. All those who met him during his recent visit to Great Britain were impressed by the energy of body and mind which Dr. Rollo displays despite the fact that he is now more than sixty years of age. To many he would appear to be a dozen years younger, and the Rhodesia University College is indeed fortunate to find a man with his experience and background, and with such vigour and forceful purposefulness, for the initial development of such an important and complicated matter as the institution of a new multi-racial university college in Africa.

Oceanography in Liverpool: Prof. J. Proudman, C.B.E., F.R.S.

Prof. J. Proudman, who is retiring from the chair of oceanography in the University of Liverpool, took his first degree in mathematics at that University and then went to Trinity College, Cambridge. He became interested in tidal theory, began research on the subject and, while professor of applied mathematics at Liverpool, prepared for the British Association a survey of the state of the practice and theory of tides at the end of the First World War. This convinced him of the need for an institute devoted mainly to research on tides, and it is due to his ability in enlisting the interest and support of Liverpool shipowners that the Tidal Institute was established in the University of Liverpool in 1919, with Prof. Proudman as honorary director and Dr. A. T. Doodson as secretary. Prof. Proudman received the Adams Prize from the University of Cambridge for an essay on tides in 1923, and with characteristic generosity devoted the money to the needs of the new Institute. That essay contained the beginnings of many important researches. Prof. Proudman was one of the British delegates to the First Assembly of the International Union of Geodesy and Geophysics in Rome in May 1922, and since then has been secretary of its Committee on Tides. He later served on other committees, notably that on Mean Sea Level, and was elected secretary of the International Association of Physical Oceanography at the meeting

in Lisbon in 1933. He held this position with great distinction until the meeting in Oslo in 1948, when he was elected vice-president of the Association, and in Brussels in 1951 he became president.

Prof. Proudman was appointed professor of oceanography at Liverpool in 1933 after the death of Johnstone, and by his teaching and researches has made the Department and the associated Tidal Institute known all over the world. He retired from the directorship of the Tidal Institute in 1945, leaving it in the capable hands of his lifelong associate Dr. Doodson. He was elected a Fellow of the Royal Society in 1925, a member of the Norwegian Academy of Science and Letters in 1946 and was awarded the Alexander Agassiz Medal for Oceanography by the U.S. National Academy of Sciences in 1946. Just as his early work on tides convinced him of the need for an institute devoted primarily to them, so Prof. Proudman's widening interests showed him the need for another laboratory to apply sound theoretical and practical methods to all the other aspects of marine physics; thus his far-seeing vision contributed largely to the foundation of the National Institute of Oceanography thirty years after the inception of the Tidal Institute.

Prof. K. F. Bowden

Mr. Kenneth Frank Bowden, who succeeds Prof. Proudman in the chair of oceanography at Liverpool, was a lecturer in Prof. Proudman's department during 1946–52. He took his B.Sc. degree with first-class honours in physics at Southampton in 1937, and his M.Sc. for research in spectroscopy in 1939. During the Second World War he served in the Admiralty Anti-submarine Experimental Establishment at Portland and Fairlie and was engaged in research, development and sea trials of a number of anti-submarine weapons. While he was at Liverpool he published a number of papers on fluctuations in tidal streams, with particular attention to the turbulent and frictional processes. He has also published several papers on the Irish Sea, with particular reference to the processes which govern the temperature and salinity distributions. In 1952 he joined the staff of the National Institute of Oceanography and has made important contributions to our knowledge of wind drift, particularly in a channel in the presence of tidal streams. His work indicates that he and his collaborators will be well able to continue the researches started by Prof. Proudman and keep pace with the increasing need for the application of sound theoretical methods to oceanography. Mr. Bowden is at present at sea in the R.R.S. *Discovery II*.

Metallurgy in Nottingham: Prof. J. W. Cuthbertson

Dr. J. W. Cuthbertson, assistant director of research at the Tin Research Institute, has been appointed to the newly established Cripps chair of metallurgy in the University of Nottingham. Dr. Cuthbertson was educated at the Manchester Grammar School and entered the Medical Department of the University of Manchester in 1919. In 1921 he transferred to the honours school of metallurgy and graduated with first-class honours in 1924. He was awarded the Simon-Carves Industrial Research Scholarship and carried out an interesting piece of research on gaseous combustion in coke-oven flues. In 1928 he was appointed assistant lecturer in metallurgy at Manchester and remained as a member of the teaching staff of that Department until the end of 1944. He was a teacher of outstanding ability, with particular interests in the general field of electrometallurgy, of which subject he was ultimately promoted to a senior lectureship. During the Second World War he was seconded to the Ministry of Supply and was concerned with the heat-treatment of shell steels, and particularly with laminated and coiled springs, work which he carried out with conspicuous success. On his resignation from the University of Manchester he went to his present post in the Tin Research Institute. While in Manchester, Prof. Cuthbertson's research work was largely in the general field of electrodeposition, a subject which has been of predominant interest throughout his career, and it is not inappropriate that he is at present the president of the Institute of Metal Finishing. He has published many papers relating both to the theory and the practice of the deposition of both pure metals and alloys; he has also worked on the fatigue testing of metals, for which he was awarded the Carnegie Research Scholarship of the Iron and Steel Institute. Further, as part of his general interest in electrometallurgy, he has carried out much work on the corrosion-resisting properties of metals and alloys, on which he is an authority, and on the constitution and properties of some ternary alloys. For many years his wide knowledge of the whole field of electrometallurgy was utilized in the preparation of the many progress reports on the electrochemical and electrometallurgical industries.

Chemical Engineering in Newcastle upon Tyne: Dr. J. M. Coulson

Dr. J. M. Coulson, at present reader in chemical engineering at the Imperial College of Science and Technology, London, has been appointed as the first professor of chemical engineering at King's College, Newcastle upon Tyne. Dr. Coulson studied at Cambridge and at the Imperial College, where he received one of the first research degrees in chemical engineering for a study on the fluid dynamics in a packed column. After leaving the College, he obtained experience in the Research and Production Departments at the Royal Arsenal, Woolwich, and, during the Second World War, he was manager of one of the large ordnance factories under the Ministry of Supply. Since 1945, he has been at the Imperial College, first as lecturer and later as reader. Dr. Coulson has carried out research in various fields of chemical engineering but particularly in the study of mass transfer in distillation and liquid–liquid extraction processes, and in heat transfer. He is the co-author of a text-book on chemical engineering, the first volume of which has just been published.

Max Rubner (1854–1932)

Max Rubner, one of the great pathfinders in the science of nutrition, was born at Munich a century ago on June 2, 1854, and began his scientific career as a pupil of Carl von Voit, the acknowledged leader at the time in metabolic research. Rubner's famous isodynamic law stating that carbohydrate and fat are interchangeable in nutrition on the basis of their calorific equivalents was worked out as early as 1878; but its publication was delayed until 1883 as it did not meet with his teacher's approval. This law is valid except when food is given in large quantities, and Rubner's 'specific dynamic action of the foodstuffs' (1902) is the governing principle. He also discovered the law of surface area, that the basal

metabolism of the resting individual is proportional to the surface area of his body. In 1883–84 he made accurate measurements of the calorific value of various foodstuffs, and his figures are still generally used throughout the world in calculating the energy values of diets. In 1885 he was appointed to the newly created chair of hygiene at Marburg, where four years later he constructed, mainly with his own hands, the first accurate self-registering respiration calorimeter for use with dogs. A similar apparatus was later made for man by W. O. Atwater and E. B. Rosa. In 1891 Rubner succeeded Robert Koch as professor and director of the Institute of Hygiene at Berlin, and in 1909, at T. W. Engelmann's death, he became professor of physiology. He retired in 1922, and died on April 27, 1932, aged seventy-eight. Throughout his career he viewed metabolism from the point of view of energy, visualizing molecular oxidative cleavage as responsible for fresh supplies of energy to make up for the unpreventable loss occurring in all living things.

Recent Greek Earthquakes

A series of earthquakes in Greece has recently caused the deaths of twenty-seven people, injury to about two hundred others and devastation over wide areas. On April 30 at about 13h. 02½m., G.M.T., an earthquake with an epicentre near lat. 39·3° N., long. 22·1° E., near Sophades was felt over an area of 1,150 square miles. It was recorded at Stuttgart at 13h. 05m. 45·5s., G.M.T., at Edinburgh at 13h. 07m. 48s., G.M.T., and at most European observatories. Forty-eight observatories, including some in places as far from the epicentre as western America, India and Pakistan, immediately sent their observations to the United States Coast and Geodetic Survey. The instrumental magnitude appears to have been near 7. In the epicentral area at Sophades and Pharsala some 60 per cent of the buildings were down, while at Karditza some 20 per cent of the buildings were destroyed. Minor damage was caused at Volo, Lamia, Larissa and Trikkala. The railway was damaged at Dhomokos. Altogether, about twelve hundred houses were estimated to have been made uninhabitable and ten thousand people rendered homeless. The damage is estimated at £2 million. Aftershocks have been frequent, and some have been strong; those on May 1 (five strong tremors), May 4 (one strong tremor), May 5 (five strong tremors) with property damage at Soupi, and May 12 (two strong tremors) have all been felt. Tremors have also been reported from Tropaia, Patras and Tripolis, and also from south-west Greece and the Peloponnese. On May 12 one of the casualties mentioned above was caused at Aspraspitia near Pirgos, and property damage was occasioned at the time there and also at Xirokambos.

New Gallery at the Science Museum, London: Gas Manufacture and Distribution

A new gallery devoted to the history of gas manufacture, its distribution and its by-products up to the present day, has been set up in the Science Museum, London, and was opened on May 25 by the Lord President of the Council, the Marquess of Salisbury. The display occupies a gallery of some five thousand square feet in a newly finished wing of the Museum and has been organized by a committee of the Institution of Gas Engineers, upon which the Gas Council, various manufacturing interests and the Science Museum are represented, the whole being under the chairmanship of Mr. F. M. Birks, deputy chairman of the North Thames Gas Board. The gallery illustrates not only the beginning of the making of gas, first for lighting and then for heating, and its industrial uses, but also the later uses of the many by-products of coal created through the gas-making process. A series of realistic dioramas shows some of the early experimenters at work, followed by representative retort houses at various dates up to the present day. A cyclorama running the whole length of the gallery depicts London's gas-lighted streets in 1812, the gas-lit scene at a Mansion House ball as long ago as 1830, private house lighting thirty years ago, and the advent of the incandescent mantle sixty-four years ago. Models representing gas-works in 1890 and 1950 show the progress of the machinery for gas-making. Illuminated panels, operated by push-buttons, show by animated diagrams the various stages in the extraction of gas from coal, how it is distributed to the consumer, and what happens to the by-products that remain. An illustrated brochure is available.

Council for the Preservation of Rural Wales

In its annual report for 1952–53, the Council for the Preservation of Rural Wales directs attention to the measures which have been taken during the twenty-five years of its existence to protect the natural countryside from despoliation and disfiguration. Among these are the substantial advances which have been made in town and country planning. Roadside ribbon development, for example, has been checked, while the principle of restoration after mineral extraction has been accepted, as well as the long-term assessment of land required for this purpose. The siting, layout and design of local-authority housing has been much improved and ugly outdoor advertising has become the subject of control. The Forestry Commission is no longer solely concerned with State forests, the proper maintenance of privately owned woodlands and the control of felling of privately owned trees now falling within its purview. The passing of the National Parks and Access to the Countryside Acts in 1949 and the establishment of the National Parks Commission and the Nature Conservancy were valuable developments, while the importance of preserving buildings has been recognized by the establishment of the Historic Buildings Councils. The Rivers (Prevention of Pollution) Act of 1951 has also led to much more effective control. The Council is less happy, however, about developments which have taken place since the electrical industry was nationalized, and a problem which has assumed considerable proportion is the rapid increase in caravan sites. The report also contains details of specific measures taken during the past year to protect the natural amenities of Wales.

Scientific and Technical Periodicals of South East Asia

The second edition of the "List of Scientific and Technical Periodicals of South East Asia" (pp. 233. Manila: South East Asia Science Co-operation Office, 1953) contains all the revisions and additions which the Office has been able to obtain from correspondents in Hong Kong, Japan, Indonesia, Macao, Malaya, North Borneo, the Philippines, Sarawak, Thailand and Vietnam; the entry for Japan is the first to appear in this list. But no revision of the list of Chinese periodicals has been possible, and the

supplement for China given in the first edition remains the most up-to-date list available. Under each country the main entry for each periodical is made under the Universal Decimal Classification, with supplementary entries where possible and useful. There is also a subject index and an alphabetical list of titles. The format and binding show some improvement on the first edition.

University of Leeds

THE University of Leeds has conferred the degree of LL.D. *honoris causa* upon Sir Arthur Trueman, chairman of the University Grants Committee during 1949–53. Dr. Frances O. Flint (at present Boltonia Fellow in the Department of Leather Industries) has been appointed lecturer in the Department of Leather Industries. The following gifts have been made to the University: £1,000 over two years to the Department of Coal Gas and Fuel Industries from the Shell Petroleum Co., Ltd., for postgraduate research in chemical engineering; a specially ruled diffraction grating from Prof. M. Siegbahn, Stockholm, to the Department of Physics for research on the electronic structure of metals; and £2,000 a year for seven years (under covenant) from Messrs. Brotherton and Co., Ltd., for lectureships and fellowships in chemistry and chemical engineering.

University of Birmingham

THE following appointments have been made in the University of Birmingham: N. G. T. Ludlow, to be lecturer in mining; Dr. P. D. Whittaker, to the D.S.I.R. research staff in physics. The title of University research fellow has been conferred as follows: Harald Klepp, a member of the staff of the Norwegian–Dutch Joint Establishment for Nuclear Energy Research, during the tenure of his post in the Department of Physics of the University; Prof. H. L. Saha, professor of physiology in the University of Calcutta, while working in the Department of Medicine; Dr. Bernard Shaw, of the Department of Pharmacology. The following have resigned: Dr. Elsie A. G. Knowles, lecturer in industrial statistics; A. R. Harding, research fellow in metallurgy; F. Aughtie, research fellow in physics; G. Marchant, lecturer in geology.

Leverhulme Research Awards, 1954

THE following Leverhulme Research Awards, among others, have been made for 1954 for work on the subjects indicated. *Fellowships:* Dr. J. C. Earl, chemistry of sydnones and similar compounds; Prof. A. M. Honeyman (professor of Hebrew and oriental languages, University of St. Andrews), archæological and epigraphic reconnaissance in south-west Arabia; and Prof. A. D. Peacock (professor of natural history, University College, Dundee), a monograph on animal parthenogenesis. *Research Grants:* J. Bor (senior lecturer in physics, West Ham College of Technology, London), determination of the optical constants of metals and alloys; Dr. S. F. Collins (lecturer in social anthropology, University of Edinburgh), social mobility in Jamaica and its relation to West Indian migration to Britain; Dr. P. H. Davis (lecturer in botany, University of Edinburgh), biological exploration in the mountainous regions of Turkey; J. R. D. Francis (lecturer in civil engineering, Imperial College of Science and Technology, London), wave motions and mixing at the interface of fluids of different densities; Dr. W. H. George (head of the Department of Physics, Chelsea Polytechnic, London), studies in musical acoustics; G. A. Kellaway (principal geologist, Geological Survey and Museum, London), the interpretation of British Pleistocene structures in the light of evidence from northern North America; S. H. F. Lloyd (director, British Institute of Archæology, Ankara), Beycesultan excavations—a supposed centre of late Bronze Age civilization in non-Hittite Anatolia; and D. M. Reid (late biology master, Harrow School), the amphipoda of the Swedish Chiloe Expedition.

Manchester Literary and Philosophical Society: Officers

THE following have been elected officers of the Manchester Literary and Philosophical Society: *President*, Dr. P. F. R. Venables; *Vice-Presidents*, Sir Geoffrey Jefferson, Dr. Norman Smith, Prof. J. Kenner and Miss A. C. Alexander; *Honorary Secretaries*, G. F. Clayton and F. Willett; *Honorary Treasurer*, H. Hayhurst; *Honorary Librarians*, Dr. W. H. Brindley and Dr. A. C. Benson; *Honorary Curator*, D. Stephenson.

National Research Council of Canada: Members of Council

THE following have been appointed new members of the National Research Council of Canada for three years from April 1: M. Henri Gaudefroy, director of the École Polytechnique, Montreal; and M. Abel Gauthier, vice-dean of the Faculty of Science, University of Montreal. Four other members, who have served for one term of office each, have been reappointed as follows for a further three years: Prof. A. N. Campbell, professor of chemistry in the University of Manitoba; Mr. Gordon G. Cushing, of Ottawa, secretary-treasurer of the Trades and Labour Congress of Canada; Dr. G. E. Hall, president and vice-chancellor of the University of Western Ontario; and Dr. Cyrias Ouellet, professor of chemistry in Laval University, Quebec.

Linnean Society of London: Anniversary Meeting

AT the anniversary meeting of the Linnean Society of London, held on May 24, the Linnean Gold Medal was posthumously awarded to Prof. F. E. Fritsch. The Trail Award and Medal was awarded to Prof. Irene Manton. The following were elected officers for the session 1954–55: *President*, Lieut.-Colonel R. B. Seymour Sewell; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. George Taylor (Botany) and Mr. H. R. Hewer (Zoology); *New Members of Council*, Mr. E. J. H. Corner, Mr. M. A. P. Madge, Dr. T. C. S. Morrison-Scott, Dr. C. F. A. Pantin and Miss E. M. Wakefield. The following were appointed vice-presidents for the session 1954–55: Prof. C. T. Ingold, Dr. C. F. A. Pantin, Prof. J. E. Smith and Colonel F. C. Stern. Dr. E. Marcus of Brazil and Dr. A. H. Uggla of Uppsala were elected foreign members, and Dr. J. G. Dony, Mr. R. H. Harris, Mr. G. B. Stratton and Mr. R. O. Williams were elected associates *honoris causa*.

The Night Sky in June

NEW moon occurs on June 1d. 04h. 03m., U.T., and also on June 30d. 12h. 26m., and full moon on June 16d. 12h. 06m. The following conjunctions with the moon take place: June 2d. 16h., Jupiter 1° S.; June 2d. 20h., Mercury 1° N.; June 3d. 11h., Venus 2° N.; June 12d. 11h., Saturn 8° N.; June 17d.

08h., Mars 3° S. In addition to these conjunctions with the moon, Venus is in conjunction with Pollux on June 12d. 04h., Venus 4·9° S. Mercury is an evening star, setting at 22h. on June 1 and at 21h. 45m. on June 15, but later on it is too close to the sun for favourable observation and at the end of the month sets about the same time as the sun. Venus is an evening star, setting at 22h. 30m., 22h. 35m. and 22h. 20m. on June 1, 15 and 30, respectively. The visible portion of its illuminated disk varies from 0·852 to 0·767 and the stellar magnitude from − 3·4 to − 3·5 during the month. Mars rises at 22h. 30m., 21h. 30m. and 20h. 15m. at the beginning, middle and end of the month, respectively, and is conspicuous until the early morning hours. Towards the middle of the month it lies a little south of λ Sagittarii, and at the end of the month it is north of γ and δ Sagittarii. On June 24 it is in opposition. Jupiter sets at 21h. 40m. on June 1 and at 21h. on June 15, but is then too close to the sun for favourable observation and is in conjunction on June 30. Saturn sets at 2h. 40m., 1h. 40m. and 0h. 30m. on June 1, 15 and 30, respectively, and is close to κ Virginis about the middle of the month. Only one occultation of stars brighter than magnitude 6 takes place in June, *e* Leonis disappearing on June 8d. 22h. 20·2m. Summer solstice takes place on June 21d. 23h.

A total eclipse of the sun occurs on June 30, visible as a partial eclipse (magnitude 0·76) at Greenwich. The circumstances of the eclipse are as follows :

	U.T. or G.M.T.	Longitude	Latitude
Eclipse begins	June 30d. 10h. 00·9m.	+ 73° 34′	+ 29° 47′
Central eclipse begins	30 11 07·7	+ 39 01	+ 42 22
Central eclipse at local apparent noon	30 12 21·5	+ 4 32	+ 61 53
Central eclipse begins	30 13 56·6	− 73 57	+ 26 19
Eclipse ends	30 15 03·4	− 50 46	+ 13 11

Much of the eclipse track lies over land, and the eclipse begins at sunrise in Nebraska, ending at sunset in north India. A joint expedition organized by the Royal Astronomical Society and the British Astronomical Association has been arranged for Sweden, and the town of Lysekil, in the totality belt on the west coast of Sweden, will be used as centre. The municipality of Strömstad has placed at the disposal of the expedition a reserved site on Bukteberget, a hill in Strömstad.

Announcements

We regret to announce the following deaths :

Sir John Blake, comptroller-general of patents, designs and trade-marks, on May 18, aged fifty-six.

Prof. S. Brodetsky, emeritus professor of applied mathematics in the University of Leeds, on May 18, aged sixty-six.

Prof. J. B. Buxton, principal and dean of the Royal Veterinary College since 1936, on May 25, aged sixty-six.

Sir Lewis Fermor, O.B.E., F.R.S., formerly director of the Geological Survey of India, on May 24, aged seventy-three.

Prof. F. E. Fritsch, F.R.S., emeritus professor of botany in the University of London, on May 23, aged seventy-five.

Prof. J. P. Hill, F.R.S., professor of embryology in the University of London during 1921–38, aged eighty-one.

Dr. R. J. de la Rivière, of the Institut Pasteur, Paris, has been elected a member of the Rural Economy Section of the Paris Academy of Sciences, in succession to the late E. Leclainche.

Under the terms of the scheme to commemorate the late Lord Rutherford of Nelson, the following appointments have been made by the Council of the Royal Society : Dr. E. Marsden, of New Zealand, to be Rutherford Memorial Lecturer for 1954 ; Dr. Marsden is delivering a series of lectures at university centres in South Africa ; Mr. D. M. Brink, a graduate of the University of Tasmania, to be a Rutherford Scholar for three years from October 1, to carry out research in nuclear physics at the Clarendon Laboratory, Oxford.

The Frank Knox Memorial Fellowship offered to a United Kingdom graduate for tenure at Harvard University during the academic year 1954–55 has been awarded to Mr. P. M. Hewlett, of Peterhouse, Cambridge. Mr. Hewlett, who is taking Part II of the Mathematical Tripos at Cambridge, intends to study theoretical physics at Harvard.

The Textile Institute Cotton Scholarship of £950 spread over three years has been awarded for 1954 to Mr. L. H. Williams, of Bradford. Mr. Williams will pursue a three-year, full-time degree course in textile technology at the Manchester College of Technology.

The Warner Memorial Medal of the Textile Institute has been awarded to Mr. R. Meredith, a research physicist of the British Cotton Industry Research Association. The Medal was inaugurated in 1930, in memory of the late Sir Frank Warner, and is awarded for outstanding work in textile science and technology, the results of which have been published, and particularly for work published in the *Journal of the Textile Institute*.

The Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year July 1954–55. Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr. N. B. Marshall, British Museum (Natural History), London, S.W.7, before the end of June.

The annual meeting and summer conference of the Society for Applied Bacteriology will be held in Edinburgh during the week commencing July 5. Original papers will be presented on the mornings of July 6 and 8, and on July 7 a symposium will be held on yeasts and alcoholic fermentations, which will include papers on techniques of the study of yeasts and on their production and uses in the fermentation industries. The remainder of the conference period will be taken up in visits of local interest. Further information can be obtained from the secretary of the Society, G. Sykes, Boots Pure Drug Co., Ltd., Microbiology Division, West Bridgford, Nottingham.

The Royal Meteorological Society will hold a two-day meeting during July 15–17 in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh 8, which will be open, without entrance fee, to non-members. The principal discussions at the meeting will be in the form of two symposia on the upper atmosphere and on meteorology and Scottish agriculture, respectively. Bookings for accommodation, excursions, etc., should be made not later than June 14, the necessary reservation forms being available from the Assistant Secretary of the Society, 49 Cromwell Road, London, S.W.7, from whom further information can be obtained.

THE DICKINSON MEMORIAL LECTURE

THE first biennial Dickinson Memorial Lecture to the Newcomen Society for the Study of the History of Engineering and Technology was delivered by Dr. Charles Singer on May 12—most appropriately, in the lecture theatre of the Science Museum, South Kensington, where the late Dr. Henry Winram Dickinson (1870–1952) was keeper of the mechanical engineering collections for a number of years prior to his retirement in 1930. The president of the Society, Mr. Rex Wailes, in introducing the lecturer, recalled that he had been an intimate friend of Dr. Dickinson almost since the inception of the Society in 1920. Dickinson, a founder member, had been its honorary secretary from its foundation until 1951 except for the two years (1932–34) of his presidency and had personally edited the first twenty-five volumes of its *Transactions*.

The title of the lecture had been announced as "The New Era in the History of Technology"; but, as Dr. Singer said, he would prefer to call it "The Happy Scholar", for that description was typical of Dickinson's life and character. He was born in Ulverston, the eldest son of the secretary of a steel firm, and was educated in Manchester at the Grammar School and at Owens College. After a short period in the steel industry, he was appointed a junior assistant at the Science Museum, where he spent thirty-five years. The most significant events of his service there were the acquisition and arrangement of some of the more important historical exhibits, notably the early Watt engines and the contents of James Watt's garret workshop. His greatest work, however, is to be found in the volumes of the *Transactions* of the Newcomen Society. These, Dr. Singer prophesied, would be regarded for many generations as the foundation of a new discipline in the study of history and as a first sign of the broadening of technical education; for, before the advent of the Society, there was no English medium for the communication of ideas or the publication of conclusions on the history of the useful arts, nor any library, other than that of the Patent Office, which had attempted to put together any collection of works on the history of technology.

On the conclusion of the lecture, Mr. Wailes presented to Dr. Singer a bronze commemorative medal, bearing on its obverse the badge of the Society (a gryphon segreant, with the motto, *Actorum memores simul affectamus agenda*) and on the reverse, "Henry Winram Dickinson 1870–1952" and the inscription, "Presented to Charles Singer M.D., D.Litt. 1954". A vote of thanks to the lecturer was proposed by Dr. A. P. Thurston, a former president of the Society and a co-founder with Dickinson, seconded by Mr. Arthur Stowers, the present keeper of the mechanical engineering collections at the Science Museum, and supported by Dr. S. B. Hamilton.

THIRD INTERNATIONAL BIOMETRIC CONFERENCE

THE Biometric Society, which now has nearly 1,200 members in fifty countries, held its third international conference in Bellagio, Italy, during September 1–5, under the presidency of Prof. G. Darmois, of Paris. The methods of biometry are coming to be used in an ever-wider variety of fields of application, and this variety was reflected in the papers presented during the week.

The Society has always interested itself in the teaching of biometry and a session was devoted to this topic, with speakers from Belgium, France, Italy and the United States. The basic problem is that of teaching a subject which is essentially mathematical to students who are at best uninterested in mathematics. C. I. Bliss (New Haven) has been giving an introductory course to biologists for some years, and he presented the replies to a questionnaire that he had circulated among his old students. Their comments were outspoken, but most of them had found the course a useful one, particularly since it enabled them to get the full benefit of expert statistical advice.

Geneticists were well represented at the conference which followed immediately after the International Genetical Congress. K. Mather (Birmingham), D. Lowry (Berkeley), J. L. Lush (Ames) and C. A. B. Smith (London) all gave papers on quantitative inheritance. This topic is of great importance in modern genetical research, and the appropriate methods of collecting and analysing data were the subject of considerable discussion. Even the basic concepts, such as heritability, are not unequivocally defined, as was pointed out by J. L. Lush, and their use and interpretation in the practical breeding of animals and plants are full of pitfalls. Up to date, most statistical work has been based on models assuming additive and independent genetic effects, and the extension of such research to more realistic models is a matter of great importance. Without some guidance from a set of fruitful hypotheses, it is

difficult to set up experiments which will provide the right kind of information on which to base further progress.

In the session on biometric methods in agriculture, much of the discussion concerned methods of agronomic experimentation in under-developed regions such as India, where large regions have to be covered and where information on fertilizer responses, etc., is largely lacking. V. G. Panse (New Delhi) described work going on at present in India, and F. Yates (Rothamsted) gave a general discussion of the planning of experiments on cultivator's fields, involving only 4–6 plots. During the past twenty years more and more elaborate experimental designs have been developed to fit the requirements of single experiments of high precision, but the need exists for the planning of large numbers of very small experiments which will provide useful information over a wide area. They must be extremely simple to avoid errors in laying them out and should, if possible, also serve as demonstrations. Factorial arrangements with fractional replication are useful, but may need some adaptation to meet local conditions.

In the session on methodological problems, F. J. Anscombe (Cambridge) reported on the analysis of sequentially obtained observations by methods assuming fixed sample size. He showed that the ordinary methods of analysis give very good approximations to the truth in most ordinary circumstances, though it is easy to construct examples where they produce quite false results. A paper by M. Keuls (Wageningen) gave rise to a lively discussion at a later session. This dealt with testing the differences between means in an analysis of variance. In a variety trial, for example, the ordinary F-test will show whether the whole set of varietal means are or are not significantly different, but the investigation of individual differences is less straightforward. Much work on this problem has been going on in the United States (Duncan, Tukey, Scheffé, etc.). The discussion showed a rather considerable cleavage of opinion, some speakers considering that the provision of exact significance tests for individual differences was of great importance, others that significance testing was largely irrelevant in variety trials, since a large enough experiment would show that all the varieties in the trial were significantly different. This question was related to a paper by M. J. R. Healy (Rothamsted), reporting on an investigation by P. M. Grundy which dealt with the fixing of the number of experiments needed to decide between two alternatives. In this investigation, the concept of significance did not arise, the economic amount of experimentation being arrived at by balancing the cost of the experiments against the loss resulting from an incorrect decision.

Most of the papers briefly mentioned above together with other contributions to the conference will be published in *Biometrics* this year. The organization of the meetings was in the hands of the Italian section of the Biometric Society, and great praise is due to the local secretary, Dr. L. L. Cavalli-Sforza (Milan), who was both ubiquitous and multilingual. Biometry, more than most disciplines, is full of local problems the solution of which is valuable both as theory and in practice, but which are frequently ignored for the want of adequate technical equipment. The posing and discussion of such problems, not only during the formal sessions, was not the least valuable part of the conference.

M. J. R. Healy

GAS ABSORPTION

SYMPOSIUM IN BIRMINGHAM

A SYMPOSIUM on gas absorption, organized by the Institution of Chemical Engineers, was held in the University of Birmingham during April 5–7, and eighteen papers were read dealing with theoretical concepts and laboratory data and with the efficiency of various types of absorbent and of different forms of absorption equipment. The conference was attended throughout the four sessions by more than two hundred people, and a lively discussion included a debate on the mechanics of absorption, particularly those where physical absorption is accompanied by chemical reaction.

J. W. Gailer, F. Goodridge and D. B. Atkin presented equilibrium and rate data for the absorption of carbon dioxide under static conditions by aqueous solutions of Abrac lye, monoethanolamine, a 50 per cent mixture of methyldiethanolamine in diethanolamine and N-amino ethyl morpholine. The last two materials were rejected as impracticable absorbents. These workers measured rates during the initial period of contact between gas and liquid, and also rates during longer contact periods. Absorption-rate was proportional to the partial pressure of carbon dioxide.

G. Edwards, R. Robertson, F. Rumford and J. Thomson have studied the absorption of carbon dioxide by liquid jets of ammoniacal solutions and have found that the rate of transfer increases with decreasing jet length and, in contrast to the paper of J. W. Gailer, F. Goodridge and D. B. Atkin, the rate is independent of the partial pressure of carbon dioxide. Experiments on cooling and dehumidifying air with refrigerated brine, using a grid-packed tower, were described by W. S. Norman, M. O. Algawi and F. H. Garner for a range of gas- and liquid-rates. The somewhat high liquid-film 'heights of a transfer unit' (2–5 ft.) may be due to the high viscosity of the brine (3–4 centipoises). A considerable brine film resistance was inferred.

D. Hammerton and F. H. Garner presented experimental data on the rate of solution of single gas-bubbles rising in water, for which a technique was developed for measuring changes of 10^{-3} ml./sec. in bubble size due to solution. Five gases were used in water and glycerol. Comparison between experimental results and theoretical predictions for rigid and for circulating spheres indicated that bubbles circulate freely at diameters greater than 0·4 cm. Surface-active contaminants reduced the transfer-rate to that predicted for rigid spheres. A novel expression for the gas film mass transfer coefficient, K_g, was proposed by S. Bakowski, from kinetic considerations:

$$K_g = \frac{1{\cdot}0 \times 10^{-6}\,(v + 60)}{M^{1/2}\,P^{1/3}}\ \text{gm.-mol./cm.}^2\ \text{sec. atm.},$$

where v is the gas velocity (cm./sec.), P the total pressure (atm. abs.) and M the molecular weight of the gas. Good agreement was obtained with data on evaporation from plane liquid surfaces and on absorption, evaporation and distillation in falling-film towers.

In the first of two papers by P. V. Danckwerts and A. M. Kennedy, three models of the liquid film absorption process—those of W. G. Whitman, R. Higbie and P. V. Danckwerts—were compared;

while the mathematical expressions from these three concepts are widely different, they lead to similar numerical predictions about the effect of chemical reaction and other physicochemical factors on absorption-rates. Measurement of transient rates of absorption for short times of contact provides data so that either the Higbie or Danckwerts model can predict absorption-rates in a packed column. A rotating-drum method was described to enable measurement of such rates for contact times less than 0·25 sec. A comparison with data from a packed column demonstrated the inadequacy of these models.

P. J. Hoftyzer and D. W. van Krevelen showed from similarity considerations that laboratory-scale determinations of chemical reaction-rates must be combined with rates of physical absorption determined on the full-scale plant for successful prediction. They derived a relationship expressed in a graph in this paper which shows that the rate of absorption is a function of the rate of feed of gas and liquid to the interface and of the rate of reaction, and they applied this relationship to the absorption of carbon dioxide in alkaline solutions. It was shown that the effective surface of packing may be much larger in the chemical reaction than in the physical mass transfer.

Some factors controlling the absorption of carbon dioxide by strong ammonia solution in agitated vessels were evaluated by R. P. Ayerst and L. S. Herbert. Work on laboratory and pilot-scale stirred vessels has confirmed over a limited range the validity of an equation relating absorption-rate to approach to complete carbonation. Principles for scale-up of such vessels are defined.

Prof. D. M. Newitt introduced a series of papers dealing with removal of carbon dioxide from exhaust gases. Conventional absorption equipment was precluded by lack of space, necessitating use of an absorbent of high efficiency, but which also had a high viscosity. The equipment was based on the Piazza still-head, adapted for absorption. B. E. Dixon described studies of the absorption of carbon dioxide in six amine solutions using these modified absorbers. A horizontal rotating plate carries vertical rings which intermesh with stationary vertical rings. The absorbent liquor is fed to the centre of the rotor plate and proceeds under centrifugal force through the annular spaces between rotor and stator in the form of sheets and sprays. Most of the absorption occurs in the spray curtain between the plates. Flow conditions and relevant features of the absorbent were studied. H. H. Chambers and R. G. Wall presented further data on pilot-scale absorbers of this type and established design principles. An absorber 10 in. high and 21 in. in diameter handled 21,500 cu. ft./hr. of air and 225 gal./hr. of absorbent. Power consumption was high. A reduction in power consumption and other advantages derived from having all the ring-baffles on the rotor were described by J. F. Alcock and B. W. Millington, absorption coefficients (K_gA) more than 50,000 cu. ft./hr./atm./cu. ft. of absorber being reported.

The regeneration of monoethanolamine used for absorption of carbon dioxide in rotary centrifugal absorbers was reported by F. A. Groves, B. W. Millington and D. M. Newitt, using an orthodox packed-column apparatus. It was pointed out that the absorber and regenerator must be considered together so that a balance can be obtained between factors aiding absorption and regeneration, respectively.

A new type of column packing—the Pall ring—was described by W. Pfannmüller. It differs from a Raschig ring in that sections of the cylinder are stamped out and bent inwards, the ring has 20 per cent more surface than a similar plain ring, and causes only 70 per cent of the pressure loss resulting from similar plain rings.

F. H. Garner, S. R. M. Ellis and Z. Bershadsky presented data on flow and pressure-loss characteristics of a single grid tray 4·25 in. in diameter, using water and air. Three types of operation were divided by critical water flow-rates. The pressure drop depends upon the type of operation, and thus it is not possible to obtain a simple correlation of pressure drop with operating variables. Pressure drop is less than that through a bubble plate for a wide range of flow-rates. K. A. Sherwin reviewed data from fourteen scrubbing installations for the removal of silicon tetrafluoride evolved in superphosphate production, these including batch and continuous spray towers, continuous jet systems and continuous packed towers; capacity coefficients were tabulated and materials of construction and design methods were considered. J. R. Howard described laboratory and commercial plant for producing nitrogen by using monoethanolamine to absorb carbon dioxide formed from the combustion of coal gas; other absorbents have also been tried. The types of plant used for washing coal gas and some factors affecting choice and design were discussed by L. Silver in a paper on problems of gas absorption in the gas industry.

AGRICULTURE IN IRAQ

COMPLETION OF CENSUS

THE first census of agriculture in Iraq has now been completed under the supervision of the Government's British statistician, Dr. K. G. Fenelon, and many interesting facts about the structure of the country's agriculture are revealed for the first time. Out of a total area of 444,442 sq. km., only 63,844 sq. km., or 14 per cent, are cultivated in agricultural holdings, the remainder being deserts (208,709 sq. km.), mountain lands, marsh lands or waste.

Of the cultivated area, 25,270 sq. km. were planted and 27,947 sq. km. were lying fallow during the census year 1952–53, the remainder being utilized for fruit trees (1,282 sq. km.), pasture (2,309 sq. km.), woodlands (578 sq. km.) or waste land (6,443 sq. km.).

About half the farm lands are dependent on rainfall alone, these being located for the most part in the north. The other half depend on artificial irrigation, which is effected either by flow (58 per cent of the total irrigated lands), where the rivers are higher than the surrounding lands; or by pumps (38 per cent) or water-wheels (2 per cent), where the river-level is below that of the fields. Miscellaneous but primitive methods of irrigation, for which baskets, manually operated buckets or animal-driven paddle pumps are used, account for the remaining 2 per cent.

A great variety of fruits grows in the country, the main kinds being pomegranates (2 million trees), oranges (1¼ million trees), apples (¾ million trees) and apricots (½ million trees). Date palm trees, which number between 20 and 30 million trees, are exceed-

ingly numerous in southern Iraq, especially in Basra province. Vegetable cultivation is widespread, main varieties being melons, tomatoes, cucumbers and egg plants; but there is unfortunately a prejudice against vegetable cultivation in certain provinces, notably Amarah and Muntafiq, where the vegetable farmers are regarded as socially inferior to those growing the bread grains.

Main crops are barley (12,100 sq. km.), wheat (10,460 sq. km.) and rice (1,287 sq. km.). The most important industrial crops are cotton (24,100 hectares) and tobacco (10,200 hectares), the latter being grown almost exclusively in the northern provinces of Sulaimaniyah, Mosul and Arbil.

Share-cropping is general, and there is a great weight of agricultural debt. Co-operation has made exceedingly slow progress; but efforts are now being made, with the assistance of foreign experts, to develop various forms of co-operation, to promote rural industries and to introduce facilities for 'fundamental education'.

SEED PRODUCTION, TESTING AND DISTRIBUTION IN EUROPEAN COUNTRIES

THE Food and Agriculture Committee of the Organization for European Economic Co-operation has published a report on an important aspect of agricultural production in eleven of the eighteen member countries which pledged themselves by signing in 1948 the convention for European Economic Co-operation. The report by Technical Assistance Mission No. 106 on "Seed Production, Testing and Distribution in European Countries"* is one of a series of reports the purpose of which is that of "increasing European agricultural production on the most efficient lines", and no one can pretend, even in the eleven countries participating—Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Sweden and the United Kingdom—that agriculture has reached a state of technical perfection. In spite of there being an apparent economic surplus of some primary products of agriculture—particularly cereal grains—at the moment, and although certain governments appear to be endeavouring to control production to stabilize prices, the world is still short of food.

In the present circumstances, therefore, this report is interesting and significant not only because of its origin, but also because of its content and its implications. Not only must there be a continuous increase in the amount of food produced, but there must also be improved efficiency in production and greater attention to quality. Although there is still not sufficient food being produced in the world to feed everyone adequately, there is, in countries with the highest standards of living, a growing concern over the increasing cost of food and a more discriminating awareness of the difference between good and poor quality. There is therefore every inducement for farmers to do everything to lower costs of production and concentrate on producing articles of acceptable quality. The recent experience of the agitation caused by the operation of a 'free market' for cereals in Britain bears out this contention.

* Seed Production, Testing and Distribution in European Countries. Technical Assistance Mission No. 106. Pp. 166+4 annexes. (Paris: O.E.E.C., 1954.)

The Food and Agriculture Committee is therefore wise in linking efficiency of production to total production, and in the present context this is recognized in the attention that has been paid in this report to the importance of seed production, testing, distribution and crop improvement as means of improving crop production in terms of quantity, quality and efficiency. The Mission responsible for the report concludes from its survey that all the countries it visited could benefit by the adoption of certain of its recommendations, and it has not hesitated to mention matters for government consideration in individual countries concerning seed legislation and regulations, seed production, and crop improvement by plant breeding.

It is only to be expected that each of the countries visited had its own particular problems and ways of dealing with these problems; but it is, nevertheless, surprising how each country reflected such different emphasis on the similar matters relating to organization, legislation and research. It is therefore not surprising that the Mission found reason to criticize and to remark upon the uneven standard between the countries, while concluding that co-ordination and co-operation between countries would confer considerable benefits. This is significant when it is realized that the countries visited have among them the most intensive and highly productive agricultures in the world, with highly organized agricultural services, commercial organizations and research.

The general impression left by the report is that much could be done to improve the position by individual national effort and by international co-operation. It is recognized by the authors that agriculture cannot reach its highest state of efficiency without an adequate supply of the best seeds for crop production, but the organization and technical efficiency do not always exist to provide this seed. In this context, it is proposed that improvements would result from better co-ordinated and more uniform crop-variety trials, while the inadequacy of such trials with certain crops in some countries is criticized. It was felt also that international action on plant quarantine regulations is desirable, while concern is expressed at the confused nomenclature in use for describing the various categories of certified seed sold in various countries. Finally, the importance of plant breeding in providing improved varieties is stressed, although it is pointed out that this is not generally recognized in all countries. Indeed, the comments on the organization and development of plant-breeding research indicate that there is much to be done to raise the general position throughout the countries visited to a satisfactory level.

VANADATE GLASSES

By E. P. DENTON, H. RAWSON and J. E. STANWORTH

Research Laboratory, The British Thomson-Houston Co., Ltd., Rugby

THERE has been some doubt as to the extent to which vanadium pentoxide can be regarded as a 'glass-forming' oxide, that is, as an oxide which can promote glass formation from melts containing no other recognized glass-forming oxide such as those

of boron, silicon, germanium or phosphorus. Hägg[1] failed to prepare a glass from vanadium pentoxide itself; but Roscoe[2] prepared V_2O_5–P_2O_5 glasses with high percentages of vanadium pentoxide (the actual composition of Roscoe's glasses is not clear from his text, but it would appear that he made glasses containing as much as 99 per cent of vanadium pentoxide). Later, Tammann and Jenckel[3] prepared glasses containing as much as 89 per cent vanadium pentoxide, the remaining 11 per cent being the glass-forming oxide phosphorus pentoxide. So far as we are aware, no glasses have been prepared hitherto containing vanadium pentoxide as the only glass-forming oxide.

In a recent paper[4] one of us described tellurite glasses containing high percentages of vanadium pentoxide; a glass with a lead tellurite base contained 57·9 per cent vanadium pentoxide and one with a barium tellurite base 69·9 per cent vanadium pentoxide. Our work made it clear, however, that tellurium dioxide must be added to the list of glass-forming oxides. These vanadium tellurite glasses are remarkable for their low annealing temperatures (between 250° and 300° C. approximately) and their relatively low electrical resistivities; it was also found[5] that these glasses, though quite black, had good infra-red transmission. A glass of percentage composition BaO 15·0, TeO_2 31·4, V_2O_5 53·6 had a linear thermal expansion coefficient (50°–200° C.) of 135×10^{-7}, a deformation temperature of 285° and a resistivity at room temperature of about $10^{6\cdot8}$. These properties were sufficiently interesting to stimulate an investigation of the possibility of preparing vanadate glasses[6].

Compositions of New Vanadate Glasses

We have actually found it possible to make many glasses containing vanadium pentoxide and one other oxide, the second oxide being itself either a glass-forming oxide such as phosphorus pentoxide, germanium dioxide, tellurium dioxide or arsenic trioxide, or a non-glass-former such as barium oxide or lead oxide. Table 1 summarizes the results obtained.

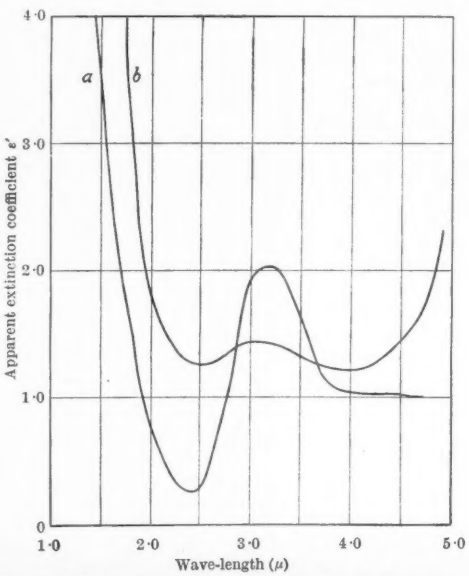

Fig. 1. Infra-red transmission curves for two glasses containing vanadium pentoxide: (*a*) 10 per cent V_2O_5, 90 per cent TeO_2, 1·78 mm. thickness; (*b*) 67 per cent V_2O_5, 33 per cent BaO, 4·25 mm. thickness. No correction has been made for surface reflexion losses, and hence the term 'apparent extinction coefficient'

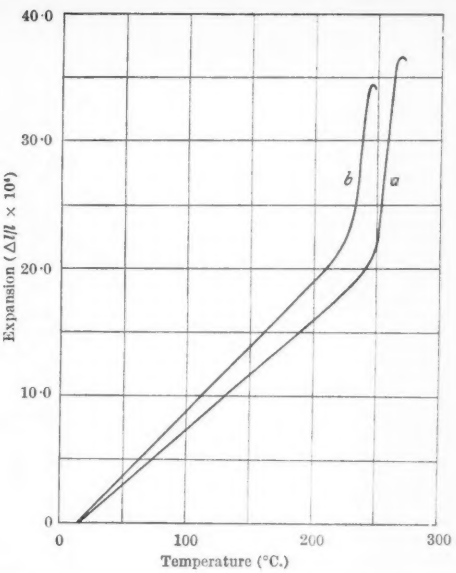

Fig. 2. Thermal expansion curves of two glasses containing vanadium pentoxide: (*a*) 67 per cent V_2O_5, 33 per cent BaO; (*b*) 83 per cent V_2O_5, 9 per cent P_2O_5, 8 per cent PbO

In the vanadium pentoxide–arsenic trioxide glasses the composition range cannot be determined with any certainty from the batch composition owing to volatilization of arsenic trioxide. It should also be noted that the composition ranges refer to ranges within which quantities of glass of the order of one or two grams can be produced without devitrification. The barium vanadate glass of percentage composition BaO 28, V_2O_5 72, however, has been prepared on a scale of 50 gm. in platinum, and lead vanadate glasses containing 52–56 per cent V_2O_5 have been melted on a scale of 20 gm. in alumina.

The vanadium pentoxide–phosphorus pentoxide glasses may be made much more durable by the addition of lead, barium or calcium oxides, and glasses of the percentage compositions V_2O_5 83, P_2O_5 9, PbO 8; V_2O_5 83, P_2O_5 9, BaO 8; V_2O_5 74, P_2O_5 18·5, CaO 7·5 have been produced successfully without devitrification in quantities of the order of 20–30 gm.

Table 1

System	Approximate range of V_2O_5 content	Crucible material used	Durability
V_2O_5 – P_2O_5	< 95%	Platinum	Water-soluble
V_2O_5 – GeO_2	10–75%	Platinum	Water-soluble
V_2O_5 – TeO_2	10–60%	Silica and alumina	Fairly good
V_2O_5 – As_2O_3	> 50%	Silica and alumina	Water-soluble
V_2O_5 – BaO	63–73%	Platinum	Good
V_2O_5 – PbO	46–62%	Silica and alumina	Good

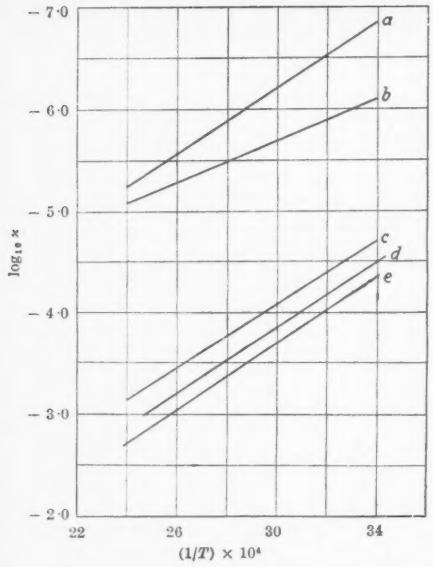

Fig. 3. Log conductivity (ϰ) plotted against $1/T$ for some glasses containing vanadium pentoxide: (*a*) 67 per cent V_2O_5, 33 per cent BaO; (*b*) 60 per cent V_2O_5, 40 per cent TeO_2; (*c*) 83 per cent V_2O_5, 9 per cent P_2O_5, 8 per cent BaO; (*d*) 83 per cent V_2O_5, 9 per cent P_2O_5, 8 per cent PbO; (*e*) 90 per cent V_2O_5, 10 per cent P_2O_5

Physical Properties

All the glasses are opaque to visible radiation; but some transmit quite well in the infra-red as shown in Fig. 1. Fig. 2 shows that the glasses can have a linear thermal expansion coefficient of about 10×10^{-6} and that the annealing temperature can be even less than 250° C.

Measurements have been made of the electrical conductivity of several of the vanadate glasses, and the results are indicated in Fig. 3; all these glasses, like vanadium pentoxide itself, are semiconductors, and tests carried out to determine the sign of the thermo e.m.f. have shown that the conduction is *n*-type. The activation energy calculated from the expression $x = x_0 \exp(-\varepsilon/2kT)$ for the glass of percentage composition V_2O_5 90, P_2O_5 10 is 0·76 eV., which is about twice the value obtained by Boros[7] for single crystals of vanadium pentoxide.

Dielectric measurements made at a frequency of $3{\cdot}2 \times 10^9$ cycles/sec. on disks of a glass of percentage composition V_2O_5 83, P_2O_5 9, BaO 8 gave values of 3·43 for the dielectric constant and 0·13 for the tangent of the loss-angle.

We thank our colleagues Mr. J. A. James and Mr. J. G. Linhart for making some of the measurements, and Mr. J. L. Davies, director of research of The British Thomson-Houston Co., Ltd., for permission to publish this communication.

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JUVENILE STAGES OF PLANTS AND THE NUTRITIONAL STATUS OF THE SHOOT APEX

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IT is well known that in many plants there are considerable differences between the early and subsequent stages of development. This distinction between juvenile and adult phases is found in all groups of plants, but is perhaps more familiar in the vascular plants, among which a majority show characteristic changes in the shape of the successive leaves of the individual seedling or sporeling. Much of our knowledge on this subject has been supplied by the extensive investigations of Goebel and his colleagues, which have been summarized in successive editions of that great work, "Organographie der Pflanzen"[1,2]. More recent work on heteroblastic development, as Goebel designated that type of ontogeny in which the juvenile stages are different from the adult, was critically discussed by Ashby[3].

The views of Goebel, originally advanced more than fifty years ago, have not gone unchallenged; but recent experimental studies at Manchester have indicated that his treatment of the problem is basically sound and requires only comparatively slight modification and extension to retain its value in the interpretation of a wide range of morphological phenomena. It is therefore felt that a contemporary reassessment of Goebel's hypotheses may be desirable, particularly since his conclusions are often ignored or rejected in current botanical literature.

Goebel's principal contribution was a realization of the importance of nutrition. Many morphologists of his period considered that juvenile leaves reflect a relatively primitive state, so that the ontogeny of the individual plant is to some extent a recapitulation of phylogeny. Goebel maintained, however, that although in some cases, for example, certain species of *Acacia*, the juvenile leaves may correspond to the adult leaves of a phylogenetically earlier species, in a majority of plants the change in form of successive leaves is no more than a response to the increasing nutritional powers of the developing germling. He held that all leaves of the plant conform to the same pattern of development, but that in juvenile leaves the development is arrested at one or other of the intermediate stages of the complete sequence necessary for the attainment of the adult form. The later-formed leaves are checked at progressively later stages of development; consequently, when arranged in order they repeat fairly closely the developmental sequence characteristic of the individual adult leaf. This principle was rediscovered in 1944 by Brown[4] in his study of leaf-development in larkspur.

If juvenile leaves are arrested organs, it might be expected that there would be a reversion to such leaves in adult plants exposed to starvation conditions, and numerous examples of this kind have indeed been described by Goebel[1,2].

Many other workers have contributed to the great body of evidence in support of a close connexion between heteroblastic development and nutrition; but much of this evidence, although convincing in its

combined impact, has suffered from the disadvantage that the methods employed for changing the nutritional status of the experimental plants have usually involved changes in other factors, such as lighting, temperature and humidity, which may be critical from the present point of view. To meet this objection, investigations on the heteroblastic development of the water fern *Marsilea* were carried out in aseptic culture, with changes in composition of the liquid culture medium as the only variable[5–9]. The lighting employed was sufficient to avoid any appearance of etiolation in the sporelings, but was inadequate for growth unless a suitable organic carbon source was provided in the medium. Results of this work demonstrated that in *Marsilea*, at least, the heteroblastic development is closely controlled by the available supply of macronutrients. For details, reference should be made to the publications listed; but the principal lines of evidence may be summarized as follows:

(1) In the absence of an organic carbon source from the culture medium, only the simplest type of juvenile leaf was produced.

(2) The adult leaf-form was obtained earlier following increase in concentration of any of the readily utilizable sugars: glucose, sucrose or fructose.

(3) When less readily utilizable sugars were supplied as carbon source, there was continued formation of juvenile leaves. A more advanced type of juvenile leaf was obtained with those sugars permitting somewhat better growth.

(4) The less vigorous plants obtained by growth on agar media formed juvenile leaves for a prolonged period before the adult leaf-form was eventually attained.

(5) Reversion of the normal course of heteroblastic development occurred in plants transferred to media lacking an organic carbon source.

(6) Similar reversion took place in plants growing on media containing an inadequate supply of mineral nutrients.

(7) Reversion to the formation of juvenile leaves was also found in (*a*) excised apices of mature plants and (*b*) isolated lateral buds, even when maintained on the normal culture medium. In these instances reversion was referred to a reduction in the surface available for absorption.

The evidence summarized above was obtained chiefly by changes in the carbohydrate supply. Preliminary work[9] has indicated that changes in the nitrogen source, whether organic or inorganic, have also marked effects on heteroblastic development.

It is not claimed that the supply of nutrients is responsible for the distinctive morphological and histological features of the leaf. Such features are not unlikely a response to the gene-controlled production of specific morphogenetic substances, as yet unidentified. It would seem, however, that under normal conditions the supply of these specific substances is not limiting, but that the attainment of the adult form is restricted by the supply of the basic nutrients required for the synthesis of protoplasm and other structural constituents necessary for growth. It may therefore be anticipated that, apart from nutrition, other factors which in any way interfere with the synthesis of such structural materials will also alter the course of heteroblastic development.

While there can be little doubt that nutritional factors are of great importance, the hypothesis of Goebel, in its original form, will not explain all instances of the occurrence of juvenile leaves. Thus, in many plants, the lateral buds commence their growth by forming juvenile leaves, even in parts of the shoot which bear adult leaves and where no nutritional deficiency is to be expected. Furthermore, juvenile leaves are frequently produced by adventitious shoots and by the sprouts developing from storage organs, although unrestricted supplies of food materials would seem to be available.

These apparent exceptions are readily explained, however, if it is postulated that changes in the nutritional status of the plant exert their morphological effects as a consequence of corresponding changes in the shoot apex. During normal ontogeny the apex undergoes a progressive development which usually finds outward expression as an increase in size. The hypothesis is advanced that the rate of this apical development is closely controlled by the supply of nutrients, but even under conditions of optimal nutrition the process is of necessity more or less gradual. Reduction in the supply of nutrients below a certain critical level leads to a reversion of the apical development, with a gradual return to an increasingly juvenile condition. This reversion is usually accompanied by a decrease in the size of the apex. It is reasonable to suppose that different levels of apical development, particularly when associated with size differences, will lead to arrest of the leaf primordia at different stages of their development; a larger apex would be expected to permit development of a leaf primordium for a longer period. The hypothesis enables us to account for the occurrence of the juvenile leaves of lateral and adventitious shoots, on the grounds that apices of these shoots are almost invariably initially smaller than the apex of the main axis. Reversion to juvenile leaves under starvation conditions is similarly accounted for by reduction in the size of the shoot apex. Other workers have also stressed the importance of changes in the shoot apex during normal ontogeny[4,10–12].

In support of the hypothesis outlined above it should be mentioned that the obconical enlargement of the developing shoot of many pteridophytes[13] and other herbaceous plants[10] is a familiar phenomenon. Studies of the behaviour of the apex during this phase of primary thickening are unfortunately rare; but in the plants which have been investigated from this point of view, there is a gradual increase in the size of the apex[13–15]. This increase in size is only one manifestation of a change in apical organization. There is often a decrease in the cell size at the apex, until a steady state is attained at the onset of maturity[14–17]. Other less evident changes are also to be expected. Investigations of changes in the apex during reversion are even fewer than studies of the behaviour during normal ontogeny; but it has been shown for *Marsilea* that growth under conditions of starvation leads to a gradual reduction in the size of the lateral meristems[6].

The changes in leaf-form discussed above are only one aspect of heteroblastic development. Differences between juvenile and adult phases affect a considerable range of morphological and physiological phenomena, and it is probable that changes in the apex which lead to the production of different leaf-forms will affect other features in a parallel fashion. Thus, in *Marsilea*, it was found that reversion to juvenile leaves was accompanied by a reversion in stelar structure to the protostele characteristic of

the sporeling[6]. Similarly, in *Dryopteris aristata*, a prolonged period of growth under unfavourable conditions resulted not only in a considerable reduction in the size of the apex, but also in a change in phyllotaxis to the simpler systems found in sporeling plants[18].

Although under normal conditions reversion of the apex is a response to inadequate nutrition, it is conceivable that certain other factors might lead to a reversion with an associated appearance of juvenile structures. It is also likely that, although some limitation is imposed on the development of a leaf primordium by the condition of the apex at the time of its inception, yet the primordium may still show an individual reaction to a change in nutritional or other factors. Thus, in *Marsilea*, production of supernumerary roots, in response to low concentrations (0·01 p.p.m.) of 2,4-dichlorophenoxyacetic acid, was associated with reduction of the leaflets to minute spikes, apparently as a result of excessive diversion of food materials[6]. Other examples are afforded by fern leaves with long-continued apical growth, in which the size of the leaflets fluctuates according to the external conditions obtaining at the time of their formation[19].

The general hypothesis advanced in the present account may also explain certain observations to which its application is not immediately evident. Thus, according to a recent preliminary note, Fisher[20], working with the trifoliate species of *Ranunculus*, *R. hirtus*, was able to obtain a reversion to juvenile leaves in adult plants by growing them at a higher temperature than control plants under the same constant conditions of light intensity and humidity. No explanation was offered; but it seems not unlikely that the effect of temperature is an indirect one, and that the appearance of juvenile leaves was a response to a reduction in the supply of nutrients by an increase in the rate of respiration or by an increase in the root–shoot ratio. It would be of interest to learn from the fuller account still to be published whether the plants producing juvenile leaves did indeed show any signs of incipient starvation or any change in the root–shoot ratio.

Working with horse-radish (*Armoracia lapathifolia*) Njoku[21] found that continued excision of the root tips led to the appearance of pinnately lobed leaves, presumably juvenile[22]. In his interesting treatment of leaf growth factors, Audus[22] explained this result by the assumption that the root tips are a site of 'phyllocaline' synthesis. It seems more likely, however, that here again we may refer the formation of these distinctive leaves to a change in the nutritional status of the plant, which may arise either by reduced uptake of essential nutrients or by diversion of organic nutrients to the roots during the healing and replacement of the damaged organs. Removal of roots and raising the temperature were indeed devices regularly adopted by Goebel and his colleagues to obtain reversion to juvenile stages.

A reversion to juvenile stages may also account for results recently obtained by Wenck[23], in a study of the effects of auxins and growth inhibitors on leaf morphogenesis. In *Codiaeum variegatum* f. *interruptum*, the mature leaves show characteristic interruptions of the lamina at one or more places, where the leaf consists of little more than a narrow stalk connecting the broader laminate portions. After treatment of the shoot apex with a lanolin paste containing 2,3,5-triiodobenzoic acid at a concentration of 5×10^{-4} gm. per gm. of paste there was a gradual reduction in size of the next few leaves and a filling in of the gaps in the lamina. Later leaves increased in size but failed to develop the characteristic interruptions. On the basis of these and similar results, Wenck criticized the widely held view[23,24] that auxin has little effect on the development of the mesophyll of the leaf. She considered that the non-laminate portions of the leaf of *Codiaeum* are inhibited by high auxin concentrations and that the continuous lamina arising in the presence of 2,3,5-triiodobenzoic acid is explained by the activity of this substance as an auxin-antagonist. It seems to me, however, that we have here yet another example of reversion to juvenile leaves, which in *Codiaeum* are known to have an uninterrupted lamina. In work with *Marsilea*[8], much lower concentrations of 2,3,5-triiodobenzoic acid (10 mgm./l.) caused a general inhibition of growth and continued formation of juvenile leaves for a long period, although recovery eventually took place. A similar persistence at the juvenile stage was obtained with comparable concentrations of indoleacetic acid and naphthaleneacetic acid[6]. In these instances the formation of juvenile leaves is evidently associated with a direct inhibition of the activity of the apex, rather than with the more usual case of a response of the apex to reduced nutrition.

Certain aspects of leaf morphogenesis have been omitted from consideration in the above account. It is known that factors such as temperature[25] and photoperiod[26] have direct effects on leaf form, apart from their indirect effects exerted by way of nutritional changes. These effects, however, are additive to the changes characteristic of normal heteroblastic development, which follows its usual course even under constant conditions of temperature and photoperiod. An interesting example of similar additive effects is afforded by the response of *Marsilea* to changes in osmotic concentration of the medium[8]. Such changes affect a number of morphological characteristics of the leaf; but the successive stages of heteroblastic development are relatively unaffected. A consideration of the submerged leaves of water plants in the light of these results has led to the view that the characteristic features of such leaves are accounted for by (*a*) direct effects of the environment, produced by water-saturation of the developing organs, and (*b*) indirect effects, which may appear after a considerable time lag, as a result of changed nutritional relationships, etc. The leaf-forms found in water plants merit a more extended discussion than it is possible to give in the present connexion, but it may be said at once that there is little support for the suggestion[24] that reduction of the lamina in submerged leaves of certain water plants is due to diffusion of 'phyllocaline' into the surrounding medium.

From the above survey several principal conclusions may be drawn:

(*a*) The heteroblastic development of many plants is a consequence of changes in the shoot apex.

(*b*) Such changes follow closely any alteration in the nutritional status of the plant, and are usually outwardly visible as changes in the size of the apex.

(*c*) In any case of reversion to juvenile leaves, which cannot be accounted for on a nutritional basis, a direct reduction in the size or activity of the apex may be expected.

I am indebted to Prof. C. W. Wardlaw for his critical comments on the present account, and for

his interest and encouragement during the experimental part of the work. [March 18.

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INHIBITION OF MAMMARY TUMOURS DURING LACTATION INDUCED IN VIRGIN MICE

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LACTATION is thought by some clinicians to aggravate certain types of breast cancer; they rarely dissociate the effect of pregnancy from that of lactation. The work of Foulds[1,2] in the mouse shows clearly that some spontaneous mammary tumours may respond to the environment of pregnancy by growing rapidly and to that of lactation by regressing. Recent work from this laboratory[3] on the hormonal control of the mammary gland has provided new information on the hormonal combinations responsible for prolactational growth similar to that of pregnancy as contrasted with lactational development. This has made it possible to study the behaviour of mammary tumours in hormonal environments simulating either that of pregnancy or lactation.

In rats with pituitary, gonads and adrenals removed, one may induce mammary growth equalling that of pregnancy by giving œstrone, progesterone, lactogenic or mammotropic hormone, and growth hormone. Then, by withholding the œstrone and progesterone and continuing the lactogenic hormone and growth hormone plus hydrocortisone or cortisone or deoxycortisone, lactation may be readily induced. In the presence of the adrenals, corticotropin may be used instead of a corticosteroid.

The hormonal combinations lactogenic and growth hormones, and either corticotropin or hydrocortisone, were tested in intact C_3H virgin mice, and regimens that would induce mammary growth with or without lactation were evolved. An experiment was then designed to test the effect of these hormones in various combinations on the behaviour of a transplantable mouse mammary adenocarcinoma. The results are briefly summarized below and provide an answer to the question of whether or not a hormonal milieu conducive to lactation alters the growth-rate of one type of transplanted mammary tumour.

Procedure. Virgin C_3H mice, approximately three months old, were inoculated with a small fragment of a transplantable mouse mammary adenocarcinoma on the initial day. The hormonal injections were begun on the initial + 7 day; and necropsies were performed on the initial + 35 day. A group of twenty mice received no injections; and by the initial + 35 day, eighteen of these had survived, all of them bearing tumours. Eleven other groups of 12–16 mice received the hormones alone or in combinations as listed in Table 1. All injections were made subcutaneously, either daily or on alternate days. When either of the two regimens was followed, the daily amounts of the different hormones used were computed as shown in Table 1.

Table 1. Daily Dosages of Various Hormones*

Period†	Lactogenic hormone	Growth hormone	Cortico-tropin	Hydro-cortisone
days	mgm.	mgm.	mgm.	mgm.
D+7 to D+18	1·0	1·0	0·03	0·2
D+19 to D+23	2·0	2·0	0·03	0·2
D+24 to D+28	4·0	4·0	0·03	0·4
D+29 to D+33	6·0	6·0	0·06	0·8

* Lactogenic preparations were estimated to contain about 1 per cent each of growth-promoting and adrenal-stimulating activities, while growth hormone had about 2 per cent of adrenal-stimulating and 5 per cent of lactogenic activity. The corticotropin did not contain detectable amounts of lactogenic or growth hormones. Hydrocortisone was given as acetate in suspension.
† Tumours transplanted on D day.

Terramycin was administered every other day in 2-mgm. subcutaneous doses from initial + 7 to initial + 33 days to the groups of mice receiving corticotropin or hydrocortisone alone or in various combinations. These hormones in the doses used render the mice more susceptible to infections. Terramycin proved helpful in the maintenance of the mice treated with hydrocortisone, but was of little avail in the animals injected with corticotropin alone. The lactogenic hormone was injected in the form of a suspension of an alum precipitate at *p*H 5·0. The corticotropin was given as a suspension in five parts of beeswax and ninety-five parts of peanut oil.

The mice were weighed, and their tumours measured every five days. At necropsy the tumours and various organs were weighed, and the mammary glands were inspected and fixed for staining *in toto*. A more extensive report of the detailed findings will be made at a later date.

Results. The more significant results are summarized in Table 2. It will be noted that the dosage of corticotropin used was lethal to most of the mice unless they received lactogenic hormone, growth hormone, or a combination of these hormones. The deaths in the groups receiving corticotropin could have been prevented by using a lower dose; but the plan was to approach or attain maximal tolerance of this hormone and to compensate with growth hormone. Although hydrocortisone was responsible for about the same weight loss or growth stasis seen

Table 2. Influence of Growth Hormone (STH), Adrenocorticotropin (ACTH), Lactogenic Hormone (MH), Hydrocortisone (F) and their Combinations on Lactation and Tumour Growth in C_3H Virgin Mice bearing a Transplanted Mammary Adenocarcinoma

Experiment	Initial* + 7		Initial + 17			Initial + 35 (necropsy)						
	Mice with tumour	Body-weight	Mice surviving	Body-weight change	Average tumour diam.	Mice surviving	Deaths since initial + 7	Body-weight change	Average tumour weight	Average left adrenal weight	Average mammary growth	Lactation
		gm.		gm.	mm.			gm.	gm.	mgm.		
Controls	20	21·8	20	1·4	7·9	18	2	5·4	6·0±0·9†	2·7	0	0/18
STH	13	22·1	13	5·8	11·1	9	4	13·9	3·3±1·1	3·3	+	0/9
MH	13	22·9	13	3·6	8·6	13	0	8·4	4·3±1·1	2·7	+	2/13‡
ACTH	13	23·3	12	−0·6	4·9	3	10	1·2§	0·1±0·03	9·3	< +	1/3‡
F	15	23·7	14	−1·6	5·4	13	2	−2·1	0·5±0·1	2·1	< +	2/13‡
STH + MH	13	21·2	12	6·2	10·7	8	5	16·2	6·5±2·3	3·0	+ + +	0/8
STH + ACTH	15	22·5	15	3·2	5·3	14	1	5·0	0·4±0·1	8·8	+ +	14/14
STH + F	15	21·9	15	−0·3	5·3	15	0	2·6	0·6±0·2	2·4	+ +	15/15
STH + MH + ACTH	14	22·2	13	2·0	6·3	13	1	6·2	0·3±0·1	6·9	+ + + +	13/13
STH + MH + F	12	21·8	11	1·6	6·1	11	1	3·3	0·4±0·1	1·7	+ + + +	11/11
MH + ACTH	16	22·0	15	1·1	4·9	11	5	4·8	0·4±0·1	6·1	+ +	11/11
MH + F	15	22·1	15	−1·6	6·9	15	0	−0·8	0·5±0·1	1·8	+ +	15/15

* Tumours transplanted on the initial day; injection begun the initial + 7 day; autopsy on initial + 35 day.
† Mean ± standard error.
‡ Lactation only in few small lobules.
§ This figure is misleading. All animals in this group except the few surviving lost weight steadily (0·7 gm./5 days).

in the corticotropin group, the mice fared better with it than with corticotropin. The mice receiving growth hormone alone or with lactogenic hormone showed a significantly greater body-weight gain than the controls or any other group. This dosage of growth hormone compensated in part for the body weight-decreasing influence of corticotropin or hydrocortisone. The beneficial effects of lactogenic hormone are not understood at present, and its contamination with growth hormone was determined to be of the order of only 1 per cent.

By the third week after tumour transplantation calliper measurements of the tumours showed that their growth-rate was being retarded in most of the mice receiving either corticotropin or hydrocortisone, and also in the mice receiving any of the combinations including corticotropin or hydrocortisone.

When studied one month after transplantation, a cancer of the type used here usually shows areas of necrosis as well as areas of healthy tumour tissue with ample evidence of rapid proliferation. In representative tumours chosen from each of the groups for histological study, this was found to be true in many cases. However, in the groups receiving corticotropin or hydrocortisone alone or in the various combinations, there was much less proliferating tumour tissue (Table 2); the areas of caseation or mucoid liquefaction were proportionately high. In some of the inhibited tumours no mitoses could be detected, and phases of tumour cell degeneration varied from one in which the cells merely appeared smaller to the stage in which only the ghost remnants of the cells were seen.

Especially interesting were the sections of tumours in which highly proliferated and lactating normal mammary gland had grown next to the tumour tissue. In such regions one could distinguish normal mammary alveoli distended with milk, and tumour tissue growing compactly or in an alveolar arrangement showing luminal secretion products.

Summary. Corticotropin or hydrocortisone, in doses capable of inhibiting the body growth of two-month old C_3H virgin mice, also interfered with the growth of a mammary adenocarcinoma implanted in these animals.

Growth hormone injected simultaneously with the corticotropin or hydrocortisone counteracted the body growth-inhibiting effects of the latter two hormones, but did not alter their tumour-inhibiting activity. When growth hormone plus lactogenic hormone were given with corticotropin or hydrocortisone this was also true.

Lactogenic hormone plus hydrocortisone or lactogenic hormone plus corticotropin also inhibited the tumour growth. The former combination caused a loss of body-weight comparable to that seen when hydrocortisone alone was used, whereas the latter combination permitted an average gain in body-weight equal to that observed with corticotropin and growth hormone.

The groups of mice receiving lactogenic or growth plus lactogenic hormones showed mean tumour weight values which were not significantly different from those of the controls. The mice receiving growth hormone alone showed a more rapid rate of tumour growth than did the controls during the first part of the experiment; but at necropsy their mean tumour weight was $3{\cdot}3 \pm 1{\cdot}1$ gm. which, when compared to the control figures of $6{\cdot}0 \pm 0{\cdot}9$, has a p value of 0·07.

The mice injected with growth hormone plus lactogenic hormone showed mammary growth equal to that of pregnancy, but were not lactating. Their mean tumour weight was the highest of any group.

The growth of the mammary gland was greatest in the mice receiving lactogenic and growth hormones plus either corticotropin or hydrocortisone. These glands also showed the greatest engorgement with milk. The tumours in the mice showing fully lactating glands were markedly inhibited, some showing no outward evidence of further growth, and others showing decreases during the last week of the experiment.

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LETTERS TO THE EDITORS

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Regularities in the Composition of Pentose Nucleic Acids

SINCE the time when they were first proposed[1], certain regularities characteristic of deoxypentose nucleic acids in general, regardless of source and composition, have become well established[2]. The sum of total purine nucleotides equals that of the pyrimidine nucleotides, and the molar ratios of adenine to thymine and of guanine to cytosine (or its analogues) are 1. We wish to report here experimental observations which indicate that similar regularities occur in pentose nucleic acids, with uracil taking the place of thymine.

These norms are usually not encountered in purified samples of pentose nucleic acid, probably owing to its great susceptibility to enzymic or other degradation during isolation. We have found these regularities in composition only when whole cells or centrifugally prepared cell fractions were subjected to hydrolysis and analysis by procedures ensuring the quantitative recovery of pentose nucleic acid as mononucleotides[3,4]. The analyses were based on previously described methods, but made use of newer spectral data for the calculation of nucleotide contents[4]. In such preparations, the pentose nucleic acid presumably remains in conjugation with its proteins, before analysis is begun, and premature degradation is minimized.

The analytical results are summarized in Table 1. It will be seen that in preparations of pentose nucleic acid of widely divergent origin the molar ratios of adenine to uracil, of guanine to cytosine and of purines to pyrimidines are generally close to 1. We have included in the table several examples, taken from the literature, in which similar relationships appear in material not likely to have suffered undue degradation before analysis. This is, however, not true of certain other published data.

Table 2

Source of pentose nucleic acid	Composition of pentose nucleic acid				
	A/U	*G/C*	*Pu/Py*	*G+C/A+U*	*G+U/A+C*
*Nucleus**					
Rat liver	0·85	0·88	0·86	1·26	1·00
Ox liver	0·81	0·87	0·83	1·28	1·01
Ox kidney	0·99	0·88	0·93	1·26	0·94
Nucleolus					
Starfish oocyte†	1·47	1·34	1·38	1·74	1·04

* The preparative media included citric acid, *p*H 4 (with and without 1 per cent gum-arabic) and benzene – carbon tetrachloride.
† Vincent, W. S., *Proc. U.S. Nat. Acad. Sci.*, **38**, 139 (1952).

Watson and Crick[5], in proposing a double-stranded helical structure for deoxyribonucleic acid, have suggested that the 1 : 1 relationships may be due to a specific pairing brought about by hydrogen-bond formation between the nitrogenous bases of the two chains and governed by the following restrictions: (1) a base carrying a keto group at the 6 position (guanine, thymine) can bond only with a base having a 6-amino group (adenine, cytosine). (2) A purine always bonds with a pyrimidine, thus maintaining a constant distance between the two chains.

Although pertinent physical data for pentose nucleic acid are not yet available and its formulation as a double helix may be difficult on sterical grounds[5], it is apparent that, as regards the analytical results presented here, a similar scheme could apply in the case of this material. In this connexion, analyses of nuclear and nucleolar pentose nucleic acid are of interest (Table 2). These show systematic deviations from the 1 : 1 relationships. In each case, however, the number of 6-keto groups (that is, guanine + uracil) is still very nearly equal to that of 6-amino groups (adenine + cytosine). This might be taken to imply the existence of structurally different species of pentose nucleic acid in the cell nucleus; for ex-

Table 1

Source of pentose nucleic acid	Pentose nucleic acid*					Deoxypentose nucleic acid*	
	No. of preparations	*A/U*	*G/C*	*Pu/Py*	*G+C/A+U*	*G+C/A+T*	*A+T/G+C*
Vertebrate cytoplasm†							
Rat liver	7	0·90	1·05	0·98	1·64	} 0·75[b]	1·33[b]
Rat liver[a]	6	0·94	1·15	1·06	1·54		
Rat kidney	7	0·90	1·06	1·00	1·60		
Rabbit liver[a]	6	0·98	1·01	1·00	1·54		
Frog liver	4	0·98	0·81	0·87	1·45		
Frog kidney	1	1·02	1·06	1·05	1·54		
Echinoderms							
Sea urchin eggs and embryos[c]	31	1·09	1·09	1·09	1·31	0·54[d]	1·85[d]
Starfish oocyte 'cytoplasm'[e]	1	0·91	1·07	1·00	1·42		
Micro-organisms							
Yeast, whole cells	3	0·93	1·09	1·00	0·90	} 0·56[f]	1·78[f]
Yeast, fraction *S*-78‡	1	0·98	1·04	1·01	1·04		
Isolated nucleoprotein							
Carp nucleotropomyosin[a]		0·93	1·11	1·04	1·88		

* *A*, *G*, *C*, *U*, *T* stand for adenine, guanine, cytosine, uracil, thymine; *Pu* and *Py* for purines and pyrimidines.
† Centrifugally separated, sedimentable and non-sedimentable preparations from cytoplasmic extracts are included. The figures are averages of closely agreeing analyses on several specimens of the same cell type.
‡ *S*-78 signifies the supernatant solution resulting from the centrifugation of extracts of ground cells at 78,000 × *g*.
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ample, (*a*) a double-stranded species composed of all four bases, paired as in deoxyribonucleic acid; and (*b*) double structures composed entirely of paired purines (adenine hydrogen-bonded to guanine) or entirely of paired pyrimidines (cytosine hydrogen-bonded to uracil).

The molar proportions of guanine + cytosine to adenine + uracil vary rather widely in different pentose nucleic acids, again paralleling the case of deoxyribonucleic acid[1,2]. No discernible quantitative relationship, direct or inverse, between this ratio in pentose nucleic acid and the corresponding ratio in deoxyribonucleic acid of the same species (Table 1) has as yet emerged. There exists, therefore, at least for the time being, no direct way to a decision, based on comparative studies of nucleotide distribution, whether deoxyribonucleic acid acts as a 'template' for pentose nucleic acid synthesis or vice versa, by either aligning sterically compatible, or rejecting incongruous, nucleotides. But it may be pointed out that guanine and cytosine predominate in all pentose nucleic acids studied here, with the exception of that of yeast, whereas adenine and thymine are the major constituents of most deoxypentose nucleic acids[2].

We shall publish later a full account of this work, which was aided by grants from the National Institutes of Health, U.S. Public Health Service, and from the Rockefeller Foundation.

Note added in proof. The following ratios were found in subsequent work on the pentose nucleic acids of *Serratia marcescens* and *E. coli*: $A/U = G/C = Pu/Py = 1{\cdot}2$; $G + U/A + C = 1{\cdot}0$. In all preparations studied in this laboratory the number of 6-amino groups thus has equalled the number of 6-keto groups; but it is possible to distinguish between pentose nucleic acids containing equimolar quantities of purines and pyrimidines (Table 1) and those in which this additional regularity is not found (Table 2 and the specimens from *S. marcescens* and *E. coli*).

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Manganese, a Co-factor of Oxidative Phosphorylation

In recent years it has been established that the oxidation of reduced diphosphopyridine nucleotide by oxygen in isolated mitochondria is connected with the generation of a number of high-energy phosphate bonds[1]. The enzyme system catalysing this sequence of oxidative reactions was isolated some time ago[2]; but this preparation lacks the ability to carry out coupled phosphorylation[3]. It has been suggested that this is due to our incomplete knowledge of the co-factors involved in the coupling mechanism[4,5]. Agents affecting oxidative phosphorylation in isolated mitochondria, such as, for example, calcium ions, have proved to be useful in the more detailed study of this mechanism[6–8]. Experiments along these lines have led us to conclude that the manganous ion forms a prosthetic group of the hydrogen transfer system, and is responsible for linking the catalytical units involved with the phosphorylative principle.

Table 1. Effect of Manganous Ions on Mitochondrial Respiration Inhibited by Calcium Ions

Each Warburg vessel contained: mitochondria, 1/12 rat liver; glycylglycine, 200 μmoles; potassium chloride, 150 μmoles; glucose, 180 μmoles; *dl*-glutamate, 60 μmoles; orthophosphate, 90 μmoles; adenylic acid, 3 μmoles; magnesium ions, 10 μmoles. Additions (where indicated); yeast hexokinase ("step 5" purity according to Berger *et al.* (ref. 15), preparation from 11 kgm. yeast dissolved in 30 ml. of 1 per cent glucose), 0·1 ml.; calcium ions, 0·33 μmole; manganous ions, 1·2 μmoles. Final volume, 2·2 ml. *p*H 7·8. Temp., 30° C. Gas phase, air. Time of incubation, 57 min.

Additions	Respiration (μatoms oxygen)
None	19·4
Hexokinase	46·8
Ca^{++}	26·2
Hexokinase + Ca^{++}	3·1
Hexokinase + Ca^{++} + Mn^{++}	46·3

Mitochondria were prepared from rat liver homogenates made in 0·25 *M* sucrose[9] containing 0·01 *M* ethylenediaminetetraacetic acid (versene)[10], and incubated in the presence of glutamate, orthophosphate and a catalytic amount of adenylic acid. Calcium ions, in a concentration of up to $2{\cdot}5 \times 10^{-4}$ *M*, slightly enhance respiration. In the absence of calcium, the addition of yeast hexokinase and glucose markedly stimulates respiration; whereas they are inhibitory if calcium is present. This indicates that the calcium ion becomes inhibitory to respiration when the concentration of adenosine triphosphate in the suspension is lowered.

Mitochondria prepared in the absence of versene are known to contain a considerable amount of calcium, originating from the tissue homogenate[11]. These mitochondria show no such sensitivity to hexokinase–glucose; on the contrary, it was in such systems that the stimulating effect of hexokinase–glucose on respiration was first observed[12,13]. We therefore considered that versene might, besides binding calcium, also remove a factor which has the ability to protect the mitochondria against the calcium effect even at low concentrations of adenosine triphosphate. Among the bivalent ions tested, magnesium, zinc, cobalt and copper were without effect. Manganese, on the other hand, in concentrations of $0{\cdot}5$–$1{\cdot}0 \times 10^{-3}$ *M*, could prevent the inhibitory action of calcium ions found in our system in the presence of hexokinase–glucose (Table 1). Moreover, manganese can restore respiration and phosphorylation in a system previously incubated in the presence of calcium ions and hexokinase-glucose,

Table 2. Effect of Manganous Ions, Adenosine Triphosphate and Diphosphopyridine Nucleotide on Mitochondrial Respiration Inhibited by Calcium Ions

Experimental conditions as in Table 1. Each vessel contained 0·1 ml. hexokinase. Additions (where indicated): calcium ions, 0·33 μmole; manganous ions, 1·2 μmoles; adenosine triphosphate, 5 μmoles; diphosphopyridine nucleotide, 5 μmoles

Added at zero time	Added from side-arm after 12 min. incubation	Respiration between 12 and 37 min. (μatoms oxygen)	Phosphorylation between 12 and 37 min. (μmoles phosphorus)
—	—	22·7	53·5
Ca^{++}	—	0·8	—
,,	Mn^{++}	2·3	—
,,	ATP	1·2	—
,,	DPN	15·0	1·2
,,	Mn^{++} + ATP	0·7	—
,,	Mn^{++} + DPN	16·9	22·6
,,	ATP + DPN	15·8	2·1
,,	Mn^{++} + ATP + DPN	20·7	49·5

if diphosphopyridine nucleotide and adenosine triphosphate are also introduced. The former alone restores respiration but not phosphorylation (Table 2).

From these findings, the following conclusions may be drawn. Those catalytic units of the respiratory chain which are capable of generating energy-rich phosphate bonds (in connexion with hydrogen transport) occur in two forms: a non-phosphorylative form consisting of the known enzyme–coenzyme compound (E–CoE, such as E–DPN, E–FAD, etc.), and a phosphorylative form which contains adenosine triphosphate as a co-factor and is linked to the non-phosphorylative form by means of manganese. This form dissociates according to the reaction:

$$(\text{E–CoE})\text{–Mn–ATP} \rightleftharpoons \text{E–CoE} + \text{Mn}^{++} + \text{ATP}. \quad (1)$$

Enzyme–coenzyme dissociates in turn according to the reaction:

$$\text{E–CoE} \rightleftharpoons \text{E} + \text{CoE}. \quad (2)$$

In the intact mitochondria, the degree of dissociation according to reaction (1) is a function of the intramitochondrial concentration of free adenosine triphosphate. In the presence of calcium, which renders the mitochondrial membrane freely permeable[14], the intramitochrondrial concentration of adenosine triphosphate becomes equal to that of the medium. If its level is decreased (by the introduction of hexokinase–glucose) below that which prevailed in the intact mitochondria, the left-hand side of reaction (1) decreases and the phosphorylating capacity diminishes. At the same time, the dissociation of the enzyme – diphosphopyridine nucleotide system according to reaction (2) becomes enhanced and free diphosphopyridine nucleotide diffuses into the medium. Thus a decrease in respiration parallels the decrease of the phosphorylative capacity (a corresponding leakage of, for example, flavine adenine dinucleotide is not critical because there is little dissociation of the corresponding enzyme system). Thus addition of diphosphopyridine nucleotide can restore the normal level of its enzyme system and, as a consequence, it also restores respiration. A normal level of (E–CoE)–Mn–ATP, that is, a normal phosphorylative capacity, can only be restored when manganous ions and adenosine triphosphate are also added.

An account of these investigations was given at the meeting of the Swedish Physiological Society on February 12.

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Mitosis and Deoxyribonucleic Acid Content of the Nucleus

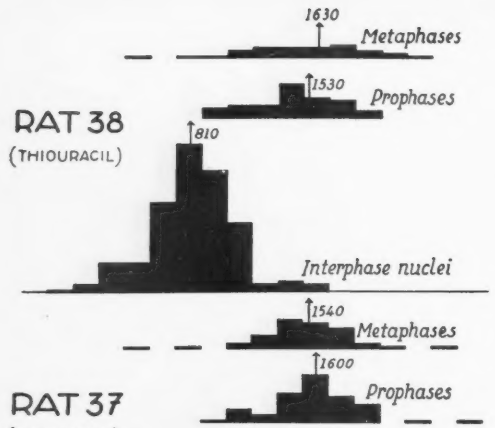
Although a certain number of exceptions have been revealed in tissues which show increased mitotic or physiological activity[1–3], it has been shown that as a rule the deoxyribonucleic acid content of the interphasic nuclei of tissues of a given species corresponds to a constant equilibrium value, which is double that of the deoxyribonucleic acid content of the spermatic nuclei of the same species. Consequently, at each mitotic division, synthesis of deoxyribonucleic acid must take place in order that the quantity of this substance should be restored in the nuclei of the daughter cells at a 'normal' level. Histophotometric measurements have shown that, contrary to classic opinion, this synthesis takes place in the interkinetic phase and not during mitosis. According to some authors, this occurs immediately before mitosis[4–7], so that the content reaches double that of the normal value: after division each nucleus of the daughter cells receives also a normal content. According to other authors[1,8–11], synthesis occurs soon after mitotic division when nuclei of the daughter cells which receive only half of the normal content restore the latter.

We have undertaken the study of this question in the thyroid cell of the white rat. For twenty-one days, rats 37 and 38 received daily doses of 20 mgm. thiouracil. The gland showed signs of cellular stimulation and mitotic divisions in sufficient number to allow histophotometric measurements of deoxyribonucleic acid at least during the prophase and the metaphase. The stages of anaphase and telophase were too rare to enable us to reach valid conclusions.

The deoxyribonucleic acid content of the nuclei in interphase, prophase and metaphase was measured with the histophotometer of Lison, the use of which has been described previously[12]. The thyroids of the two rats were fixed in alcohol–formalin–acetic acid (75 : 20 : 5 per cent) under standardized conditions. The sections were sufficiently thick so that they contained a great number of nuclei in their entirety. The different specimens which had to be compared were put on the same slide in order to obtain a homogeneous Feulgen reaction. The optical density of a Feulgen-stained nucleus measured in the wave-length region 5200–5400 A. with the histophotometer and multiplied by its projected surface gives a relative value of the deoxyribonucleic acid content of the examined nucleus. No attempt was made to calculate the absolute value of the deoxyribonucleic acid content.

The results of the different measurements are shown in the accompanying histogram. The relative amounts of deoxyribonucleic acid are plotted logarithmically on the abscissæ, and the relative frequencies of the classes comprised between two successive figures of the horizontal scale are plotted as ordinates.

In the two rats, two hundred nuclei of the thyroid in interphase were measured. In each rat the histogram shows a regular curve with a frequency maximum around 810 or 850 units and also a small second frequency maximum to the right of the first. It should be emphasized that this 'tail' towards the right was absent in the thyroid of five control animals, which showed no appreciable mitotic activity. The constituents of this second frequency maximum are few in number; consequently, it is not possible to assess with precision the mean value. All that can be safely



Deoxyribonucleic acid content of the nucleus and mitosis in the thyroid gland of the rat stimulated by thiouracil

said is that it reaches an order of magnitude nearly double that of the main peak represented on the histogram.

We have been able to measure the deoxyribonucleic content of the nuclei in prophase (fifty-six in rat 37 and fifty-one in rat 38) and of the nuclei in metaphase (forty-one in rat 37 and twenty-seven in rat 38). The results obtained allow us to calculate the mean values indicated on the histogram. In one case this value (1,630) corresponds to double that of the main value of the nuclei in interphase (810); in the three other cases, it is slightly lower than double. This discrepancy can be explained by the fact that measurements on more condensed deoxyribonucleic acid in the prophases as well as in the metaphases give values which are too low.

These measurements show clearly that in our material deoxyribonucleic acid is synthesized immediately before the onset of mitosis. Indeed, all the prophases show a deoxyribonucleic acid content which is double that of the interphase. This doubled value is also observed in the metaphases. Moreover, in thyroids in which there is intense mitotic activity a few nuclei show an appreciable increase of the deoxyribonucleic content. They are probably nuclei in which the synthetic process has taken place. The scarcity of such nuclei in relation to interphasic nuclei with 'normal' deoxyribonucleic acid content suggests that the synthesis occurs just before the onset of prophase.

It is interesting to mention that this result was obtained in the same laboratory and by a method identical with that used by J. Fautrez and N. Fautrez-Firlefyn in the blastula of *Artemia salina*[11]. On this material the synthesis of deoxyribonucleic acid takes place immediately after mitosis. That different results have been obtained in these conditions confirms the hypothesis put forward by J. Fautrez and N. Fautrez-Firlefyn that the different results obtained by different authors are the result of the material used rather than caused by a faulty technique.

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A Browning Reaction between Thiamine and Glucose

During some experiments on the non-enzymatic browning reaction between reducing sugars and nitrogenous compounds, it was found that a mixture of glucose and thiamine-hydrochloride showed considerable browning when heated in sealed glass tubes at 85° C. for some days. The experiment was repeated on a larger scale and the results seem worth publication.

Equal weights (3 gm.) of glucose and thiamine-hydrochloride were thoroughly mixed and 0·250 gm. of the mixture was put into small glass tubes, which were sealed afterwards. The moisture content of the mixture was 1·5 per cent. Ten tubes were placed in an oven at 85° C. Every day one tube was removed and stored at room temperature until all of the tubes had received heat-treatment and the contents could be submitted to further analysis.

The contents appeared to be soluble in water, even after ten days at 85° C., and the heated samples were dissolved in 100 ml. of distilled water. The resulting solution was analysed for: (1) glucose (cupric reduction method); (2) thiamine (colorimetrically with (*a*) and without (*b*) absorption, (*c*) fluorometrically (thiochrome), and (*d*) microbiologically; (3) colour (measured at 410 mμ; colour units are extinction values of a Coleman Junior Spectrophotometer scale); (4) fluorescence (a standard quinine sulphate solution, 1 γ/ml. = 200).

Glucose and thiamine values were calculated as percentage recovered from a prepared mixture of equal weights of glucose and thiamine-hydrochloride respectively.

In Table 1 the results obtained from samples treated for 0, 5 and 10 days are listed.

Table 1

Days of heat treatment	Glucose (per cent)	Thiamine-hydrochloride			Colour	Fluorescence	pH
		Method					
		a	*b*	*c*			
0	96·2	101·2	101·2	101·2	0·000	5	3·8
5	89·2	96·8	91·4	—	0·032	44	3·7
10	69·2	91·6	87·4	87·4	0·176	88	3·6

From these results (Table 1) the conclusion could be drawn that a reaction takes place between glucose and thiamine-hydrochloride. With prolonged heat treatment the amounts of both components decrease significantly, while on the other hand colour and fluorescence increase. In this connexion, spectrophotometric data were obtained from the 1 : 10 solution in the region 210–300 mμ. However, the ultra-violet analysis showed only the absorption spectrum of thiamine, which remained unchanged even after the ten days heat treatment. Moreover, the glucose absorption was completely suppressed by the thiamine. Hence it was not possible to get information whether carbohydrate breakdown might have occurred during heating.

The reaction seems to be limited to low moisture conditions, as a solution of the mixture (250 mgm./100 ml.) did not brown after heating at 85° C. for ten days.

The rate of browning is dependent on the nature of the reacting aldose, since the same experiment with a mixture of arabinose and thiamine showed a considerably greater browning effect under the same conditions.

In Table 2, the results obtained from a similar experiment, in which glucose was replaced by arabinose, are summarized. An increased rate of destruction of sugar and thiamine becomes clear, the only difference being that the fluorescence of the solutions remains of the same order.

Table 2

Days of heat treatment	Arabinose (per cent)	Thiamine-hydrochloride (per cent)			Colour	Fluorescence
		Method				
		a	*c*	*d*		
0	104·2	96	96	96	0·008	37
5	60·6	78	—	—	0·268	52
10	39·2	74	74	72	0·890	18

The same experiment was also carried out with glucose and a much lower concentration of thiamine-hydrochloride, namely, 200 μgm. thiamine per gm. of sugar. 1-gm. samples of this mixture were heated in sealed glass tubes for ten days at 85° C. In Table 3 the results are given as averages of six similarly treated samples. The contents of the tubes were dissolved in 100 ml. of distilled water and analysed as described earlier.

Table 3

Days of heat treatment	Glucose (per cent)	Thiamine-hydrochloride (per cent)			Colour	Fluorescence
		Method				
		a	*c*	*d*		
0	98·6	95	—	—	0·000	5
10	97·4	16	15	1	0·045	31

Spectrophotometric data from the undiluted solutions of the heated samples of this last experiment revealed a distinct absorption maximum at 285 mμ (Fig. 1).

This curve could indicate the formation of hydroxymethyl furfural as a result of a glucose breakdown during the browning reaction, a fact which has been reported before by a number of authors[1,2].

We consider these results of importance in several respects: (1) A striking similarity appears to exist between our results and the reaction between amino-acids and sugars, known as the Maillard reaction. The glucose – thiamine reaction could therefore be one of the factors that contribute to the well-known non-enzymatic browning of many processed foods[3,4]. (2) Particularly from the nutritional point of view, this thiamine glucose reaction needs further attention, as it might prove to be a major cause of the decreased thiamine content in a number of heat-treated foods.

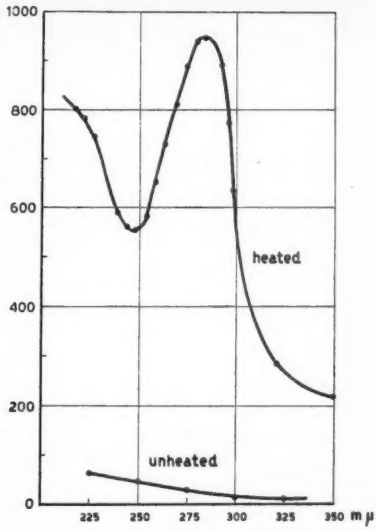

Fig. 1

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Lipid Content of 'Standard' and 'Incomplete' Influenza *A* Virus

The term 'incomplete' virus was used by von Magnus[1] for designating products appearing on serial intra-allantoic passage of large inocula of influenza virus, and distinguished from 'standard' virus obtained after inoculation of diluted seed material by the apparent lack of infectivity with retained high hæmagglutinating capacity. In sedimentation studies Gard, von Magnus *et al.*[2,3] found the incomplete virus to be more inhomogeneous than standard virus and to have a considerably lower sedimentation constant. Birch-Andersen and Svedmyr[4], examining several preparations in the electron microscope, failed to demonstrate any significant differences in the mean particle sizes, although the incomplete virus tended to show a somewhat wider variation in size and morphology.

As, thus, the lower sedimentation-rate of the incomplete virus could not be accounted for by a smaller particle size, the assumption of a lower

density seemed to offer the most likely explanation. A low density could be due to hydration or to differences in chemical composition, primarily in the lipid content. The latter possibility was tested as follows.

All experiments were carried out with the *PR* 8 strain of influenza *A* virus. Standard and incomplete virus was prepared essentially according to von Magnus's methods[5]. Infectivity was always assayed on the freshly harvested material. Hæmagglutination titres were determined by the Salk technique, using 0·25 per cent red cell suspensions. The infectivity to agglutination (*I*/*A*) ratio, expressed as the logarithmic difference between the respective titres, served to characterize the preparations.

Batches of infected allantoic fluid from 300–400 eggs were spun in a Sharples centrifuge and the deposit resuspended in about one-tenth of the original volume. The material was further purified by three cycles of low–high speed centrifugation (5,000–27,000 r.p.m.), the last cycle after overnight dialysis against distilled water. The final deposit was lyophilized and dried to constant weight over potassium hydroxide. 15–20 mgm. of the dried product was extracted for three hours in a Soxhlet apparatus with freshly distilled ethanol–ethyl ether (3 : 1). The solvent of the extract was removed by evaporation at a temperature below 60° C. and the amount of extractable material determined by weighing.

With three different batches the results as shown in Table 1 were obtained.

Table 1

Material	*ID* 50*	*HA*-titre*	*I*/*A* ratio	Lipids (per cent)
1 Standard passage	9·7	3·6	6·1	29·(7)
2 Standard passage	8·9	3·9	5·0	36·(0)
3 'Third passage'	3·9	3·6	0·3	54·(3)

* log units per ml.

Furthermore, one batch of a formolized *PR* 8 vaccine stored in the cold room for a considerable period of time was processed in the same way. No data concerning the original infectivity were available, and consequently the *I*/*A* ratio could not be determined. According to the method of preparation, however, the vaccine should correspond to a standard virus. The content of ethanol–ethyl ether-soluble substance was determined at 30·(0) per cent, in satisfactory agreement with the value obtained with standard virus batch 1, as also with the figures published by Taylor[6].

In contrast, a remarkably high lipid content was found in batch 3 which, as judged by the *I*/*A* ratio, should for all practical purposes represent a 'pure' incomplete virus with only the minutest traces of standard virus.

It should be mentioned that the differences in chemical composition were reflected also in the appearances of the lyophilized preparations. While standard virus appeared as a white fluffy powder, the incomplete virus had a yellow tint and a fatty consistency.

Batch 2, intended to be a standard virus, turned out like a 'first passage', which sometimes happens[3]. The *I*/*A* ratio indicates a composition corresponding to approximately 10 per cent standard and 90 per cent incomplete virus. The high lipid content of batch 2 has to be viewed against the background of this fact.

A comparison between *I*/*A* ratios and lipid contents in this preliminary limited series of experiments suggests a progressive change in the composition of the incomplete virus in the course of successive passages, in accordance with the results of the sedimentation analysis[3].

The investigation is being continued.

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Utilization of Topically Applied Methionine by the Guinea Pig

A study has been made of the absorption of topically applied amino-acids by the guinea pig, and evidence has been obtained that methionine labelled with sulphur-35 can be absorbed through the skin of the animal and that cystine containing sulphur-35 is present in the newly grown hair. Earlier work on the utilization of methionine was carried out by Tarver and Schmidt[1], who showed that sulphur-35 fed to rats as methionine can be found in the form of cystine in the hair and in the other tissues of the body.

An aqueous solution containing 0·175 mgm. per ml. of methionine containing sulphur-35 (initial specific activity 0·127 mc. per mgm.) was used for (1) intramuscular injection, (2) direct feeding and (3) topical application to a shaven area of the back, the application being made by gentle rubbing or massage. Hair from the treated animals was clipped at weekly intervals, washed by a standardized procedure and its radioactivity determined under standard conditions.

Preliminary experiments with injected animals showed that the peak radioactivity was reached two weeks after the injection. Sulphur-35 was detected in the newly growing hair for some two months. The recovery of sulphur-35 from the whole of the hair grown during the experimental period was computed to be 5 per cent for an initial dose of 8·4 μgm. and 3 per cent for a dose of 42 μgm. methionine sulphur-35.

Four sets of animals subjected to topical application of the methionine were treated with measured amounts of the solution on each of four consecutive days per week, the time of application being extended over four weeks. The hair from these animals showed a steady build-up of radioactivity, which was followed by gradual fall over the next two months during which no methionine was applied (Fig. 1). In the four groups the total amount of methionine rubbed in over the four weeks was respectively 34, 134, 336 and 441 μgm., and at each of these levels the recovery of sulphur-35 from the whole of the hair grown during the period of the experiment was computed to be about 1 per cent of the amount used.

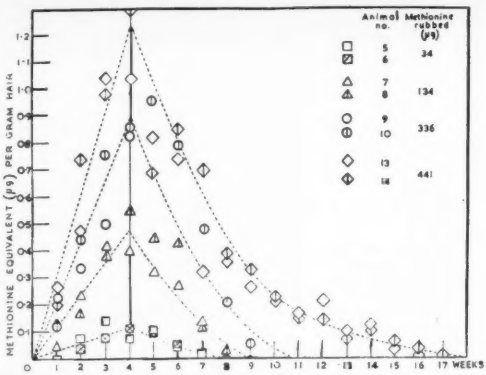

Fig. 1. Uptake of methionine sulphur-35 in hair of rubbed guinea pigs

A number of animals were fed with the methionine solution at the 441-μgm. level for four consecutive days a week over a four-week period in order to compare the efficiency of topical application with actual ingestion. It was computed that the hair of the animals fed with methionine contained some 2 per cent of the total methionine employed, that is, the efficiency was about twice that of the topical application.

A paper chromatogram of the original methionine solution showed that the radioactivity was concentrated in a narrow band with a peak at about R_F 0·5. Radioactive hair hydrolysed with 10 *N* hydrochloric acid was run as a wide chromatogram, and afterwards cut into strips; the peak activity, measured radiometrically after elution from the appropriate strip, was found at R_F 0·2, which corresponded with the cystine hydrochloride band. A control hydrolysis of unlabelled hair with added methionine containing sulphur-35 gave a chromatogram with peak activity at R_F 0·6 and a small secondary peak at about R_F 0·3. The main peak corresponded to methionine hydrochloride and the smaller peak, not yet identified, may probably be an oxidation product.

Care was taken to perform these experiments under conditions that minimized the risk of direct ingestion of radioactive material by animals receiving topical applications. A consideration of the recovery figures in the hair of the animals fed with radioactive methionine showed that if the animals receiving topical applications had not absorbed any of the methionine through the skin, then they would all have had to eat approximately half the applied amino-acid to account for the observed activity in the hair. Under the working conditions, the accidental ingestion of so large a fraction of the total application would have been impossible.

Thanks are due to Dr. R. H. Marriott for his original suggestion and continued interest; to Mr. D. M. Brown and Mr. E. W. Powell for useful discussion and suggestions; and to Mr. J. A. Dimsdale and Mr. T. L. Hardy for their assistance with the experimental work. A more detailed account will be published elsewhere.

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Elimination of the Fluorescence of Œstrogens in Urinary Extracts by Hydrogen Peroxide

Fluorimetry is now recognized as a very sensitive method for the quantitative determination of natural œstrogens. Unfortunately, when applying this method to urinary extracts, it was found that fluorimetric values are influenced by a large amount of non-œstrogenic fluorescent materials. We are now attacking the problem of removing this interference. This can be partly accomplished by further purifications of the extracts, either by counter-current distribution[1] or by chromatography[2,3].

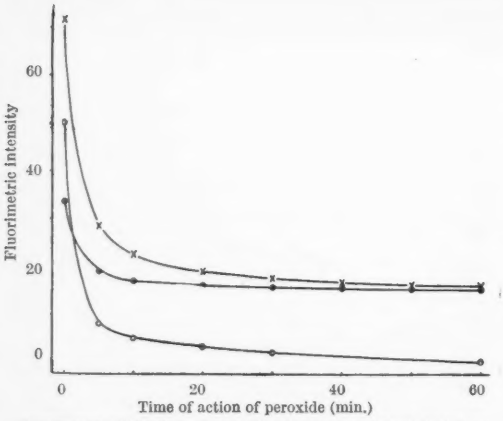
We think that an approach to this problem is possible by the elimination of the fluorescence developed by œstrogens in urinary extracts, and the subsequent subtraction of the measured residual non-œstrogenic fluorescent materials. As Kober[4] and Marrian[5] have pointed out, hydrogen peroxide can destroy the pink coloration due to œstrogens which appears in Kober's test. Recently, Veldhuis[6] has mentioned the disappearance of the fluorescence due to œstrogens after treatment of blood extracts with hydrogen peroxide or ceric salts. A similar procedure can, in our opinion, be used for the fluorescence developed by œstrogens in urinary extracts when heated with sulphuric or phosphoric acid.

We observed that, following the addition of hydrogen peroxide (5 per cent of total volume) to fluorescent solutions of œstrogens containing 10 μgm. œstrone treated by Bates and Cohen's method[7], the amount of the fluorescence decreases at a speed proportional to the concentration of the oxidizer. It disappears totally after 120, 60, 30 or 10 min. with 10, 20, 40 or 100 per cent hydrogen peroxide respectively. With œstriol, quenching is still more rapid.

The application of such a procedure to urinary extracts raises the problem of the specific action of hydrogen peroxide towards the phenolic steroids. We think that, in this case, the addition of 5 per cent by volume of 20 per cent hydrogen peroxide to the fluorescent solutions gives the best results.

As can be seen from the accompanying graph, the amount of fluorescence of a solution of 5 μgm. œstrone decreases very quickly following the addition of the oxidizing reagent and is totally destroyed after 60 min. The same decrease occurs with urinary extracts during the first few minutes, and then becomes stabilized. On the other hand, with a similar urinary extract to which 5 μgm. œstrone has been added, a rapid decrease occurs during the first 15 min., and then slows down. After 60 min., the fluorescence intensities are similar for both extracts, no matter whether œstrone has been added or not. It thus seems that, after one hour, the residual fluorescence cannot be ascribed to œstrogens, the fluorescence of which is by that time totally destroyed, but is due in large part to the non-œstrogenic fluorescent background of urinary extracts. This confirms the view that only a part of the fluorescence of urinary extracts can be imputed to the œstrogens they contain[1].

Solutions of hydrogen peroxide of higher concentrations make the measurement less specific for phenolic steroids. Furthermore, such solutions develop air-bubbles which hamper the fluorimetric measurements. In the case of non-purified urinary extracts, the action of hydrogen peroxide may result in an increase



Destruction of the fluorescence of œstrogens by 20-vol. hydrogen peroxide: ○—○—, œstrone; ●—●—, urinary extract; ×—×—, urinary extract and œstrone

of the fluorescence. This fact is due to the oxidization of substances producing in the solution an absorption of the non-specific fluorescence.

The procedure outlined can be carried out with most of the fluorimetric methods described in the literature. However, with Engel's method[1] we observed the development of a brown colour after the addition of hydrogen peroxide, which made measurement impossible.

Consequently, it seems that the subtraction of the residual fluorescence of urinary solutions after action for 1 hour of 5 per cent by volume of 20 per cent hydrogen peroxide, from the initial fluorimetric intensity figures, gives more specific values in the estimation of urinary œstrogens. This procedure, very suitable for routine determinations, must be considered more as an approach than as a definitive answer to the problem of the specific fluorimetric estimation of urinary œstrogens. The method previously described[3], when modified as described here, gives, during the menstrual cycle, elimination-rates for œstrone that correspond even better with the values given by biological tests.

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Action of Ionizing Radiation on Aqueous Solutions of Carbohydrates

Very little work has been reported in the literature on the effects of ionizing radiations on aqueous solutions of carbohydrates[1,2]. Attention appears to have been focused on some of the physical changes observable during irradiation, for example, *p*H, optical rotation and reducing power, and no study has been made of the products formed in these reactions. Because of the wide occurrence of carbohydrates in Nature and their important biological functions, a study of their decomposition by ionizing radiations was undertaken, and a summary of the results is presented here.

Three naturally occurring hexoses, D-glucose, D-galactose and D-mannose, were irradiated in dilute aqueous solution ($\leqslant 5 \times 10^{-2} M$) with 1-MV. electrons from the Chemistry Division Van de Graaff generator at Harwell. Contrary to expectations, the radiation produced highly specific changes in the molecule. From the hexoses, the only product formed was the corresponding uronic acid, attack by the radicals formed being confined to the primary alcohol group at C6 in the sugar. The yield of uronic acid was independent of the initial hexose concentration within the range $5 \times 10^{-2} M$ to $5 \times 10^{-5} M$, providing adequate demonstration of the 'indirect' nature of the radiation action. The energy of the electron beam is absorbed almost exclusively by the water, and the chemical change is due to the secondary effect of the radicals produced during the radiolysis of the water. There is exact coincidence between the behaviour of the three hexoses, the G value (yield of uronic acid in molecules/100 eV. energy input) being the same in each case and equal to 0·4 for evacuated solutions. Under these conditions, there is also a continuous evolution of gas during irradiation, the pressure rise above the liquid surface showing a linear dependence on irradiation dose. The gas was mainly hydrogen (87 per cent), carbon dioxide (10 per cent) and a small amount of carbon monoxide.

The presence of oxygen had a marked enhancing effect on the rate of production of uronic acid, and under such conditions hydrogen peroxide becomes one of the major products. In an oxygenated solution, the uronic acid and hydrogen peroxide are, in fact, produced in equimolecular proportions ($G = 1 \cdot 9$). It was observed both for evacuated and oxygenated solutions that a slow reaction continued after the irradiation had ceased. This slow post-irradiation process can be identified with a slow thermal reaction which is possible between uronic acids and hydrogen peroxide (cf. Everett and Sheppard[3]).

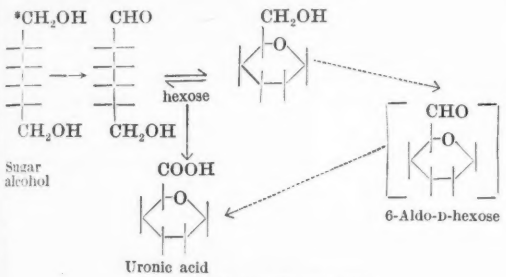
Reactions very similar in form to the production of uronic acids from hexoses have been encountered outside the carbohydrate field. For example, Weiss[4] found that when an aqueous solution of lactic acid is irradiated with 200-kV. X-rays, pyruvic acid is produced; ethyl alcohol under similar conditions gives acetaldehyde[5,6]. The general form of this series of reactions appears then to be:

$$R.CH_2OH \longrightarrow R.CHO.$$

It would be extremely difficult to obtain direct evidence of this step from the irradiation of hexose solutions, because under these conditions the intermediate D-hexodialdoses are unstable. The sugar alcohols, however, present a better comparison because the aldehyde, if formed, would be stable, being in fact an aldose sugar. For this reason the irradiation of aqueous D-mannitol solutions with 1-MV. electrons was studied. The product from this reaction is D-mannose, and this is not converted into mannuronic acid until quite appreciable concentrations have been built up in the solution. This provides a highly specific and efficient method of preparing aldose sugars from sugar alcohols. Oxygen again has a marked effect on the reaction, but here it was interesting to observe that the stoichiometric balance between hydrogen peroxide and mannose is different, the

amount of hydrogen peroxide being double that of mannose [G(mannose) = 1·5; G(hydrogen peroxide) = 3·0].

Production of mannose from mannitol gives strong support to the view that uronic acids are produced from the hexoses by way of the intermediate aldehyde, 6-aldo-D-hexose. The complete reaction may then be represented as follows:



*Configuration according to sugar

Through the kindness of Dr. M. Ebert and his colleagues at the Medical Research Council Radiotherapeutic Research Unit, Hammersmith Hospital, it was possible to study the behaviour of aqueous mannitol solutions when irradiated with 190-kV. X-rays and obtain a comparison with the electron irradiations described above. The results were of interest in that the G value for mannose formation was about 25 per cent higher than the electron value. Dosimetry of the X-rays was with ferrous sulphate solutions, a value of G(ferric iron) = 15·5 being used in the calculations. Using G(ferric iron) = 19·9, the divergence would, of course, increase still further. Further work on a comparison between X-rays and electrons is in progress; the difference due to the changed quality of radiation must obviously be regarded as quite significant.

The results will be presented in full and the detailed mechanism of the reactions considered elsewhere.

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Spectroscopic Examination of Punicic Acid

Punicic acid was first isolated from pomegranate (*Punica granatum*) seed oil by Toyama and Tsuchiya[1]. This fact was later confirmed by a re-investigation of the oil by Toyama and Hozaki[2] and also by other workers[3].

Following the results of ozonolysis and identification of the decomposition products, punicic acid has been accorded a 9 : 11 : 13 octadecatrienoic structure. However, no identity has been attached to the geometric configuration of the unsaturation other than to indicate that it is presumably a stereoisomer of elaeostearic acid which itself is known to exist in the α- and β-forms. It is therefore of interest to attempt to establish the true configuration of the double bonds present.

Absorption spectroscopy is ideally suited to the determination of *cis* and *trans* isomers, and a previous publication[4] has been concerned with the identification of the orientation of some C_{18} unsaturated fatty acids. These included both α- and β-elæostearic acids, which have been accorded conjugated *cis–trans–trans* and *trans–trans–trans* configurations respectively. A further publication[5] dealt with the spectroscopic examination of pomegranate seed oil; but at the time no sample of punicic acid was available and it was only possible to postulate the *cis–trans* orientation of the component acid from measurements on the absorption spectrum of the oil. Since that time a sample of punicic acid has been prepared, and the present communication is concerned with its ultra-violet and infra-red absorption spectra and their interpretation in terms of the corresponding data recorded for the oil.

Dried and crushed pomegranate seeds were placed in a Soxhlet apparatus and extracted with 40–60 petroleum ether for several hours, following which the solvent was distilled off under nitrogen and the last traces removed by blowing nitrogen through the oil at 100° C. In this manner, about a 15 per cent yield of oil was obtained calculated on the weight of seed taken. About 5 gm. of the oil was then saponified by refluxing with 2 gm. potassium hydroxide dissolved in 2 ml. water and 18 ml. ethyl alcohol for two hours under nitrogen. The mixture was diluted with water, acidified with hydrochloric acid and the fatty acids extracted with ether. This extract was then washed with water until neutral, dried over anhydrous sodium sulphate and the ether removed. The fatty acids thus obtained were recrystallized three times from methanol, the final product being a white crystalline solid, melting point 43·5–44·5° C. The latter figures are in agreement with published data.

The ultra-violet spectrum of the acid has been recorded over the wave-length range 220–300 mμ in cyclohexane solution with a Beckman spectrophotometer[6]. Three sharp bands are noted in the 270-mμ region characteristic of the conjugated triene system, and the wave-lengths are in good agreement with those reported for the oil. A comparison of the wave-lengths and specific extinction coefficients (k) of the principal bands for both acid and oil are noted below:

Punicic acid	265·5 mμ	275·0 mμ (k = 171·9)	287·0 mμ
Pomegranate seed oil	265·0 mμ	274·5 mμ (k = 122·1)	285·0 mμ

The infra-red spectrum of the acid has been recorded over the wave-length range 2·5–15 μ in carbon tetrachloride and carbon disulphide solutions as appropriate with a Perkin–Elmer spectrometer[7]. In addition, quantitative measurements have been made on the absorption bands in the 10-μ region characteristic of the *cis–trans* vibrations. The absorption characteristics for the acid and those for the oil previously reported are noted below:

Punicic acid	10·67 μ (k = 0·700)	—	10·12 μ (k = 0·632)
Pomegranate seed oil	10·67 μ (k = 0·366)	10·36 μ (k = 0·159)	10·12 μ (k = 0·611)

The absence of an absorption band at 10·36 μ, in the spectrum of the acid, which is known to arise from the presence of non-conjugated *trans* unsaturation in the oil, corroborates the purity of the acid.

The difference in the specific extinction coefficients of the principal absorption bands at 10·12 μ arises from the necessarily lower punicic acid character of

the oil. The corresponding large difference noted at 10·67 μ results from the contribution at that wavelength of the bending vibration absorption of the carboxylic group, which is, of course, present only in the acid.

Finally, the results of the absorption spectra measurements on punicic acid in this present work are in good agreement with those previously reported for the parent oil. In view of the fact that the latter set of data has previously been assumed characteristic of the component acid, for the identification of the unsaturation, this conclusion would seem to justify the suggested *cis–cis–trans* configuration.

Acknowledgments are due to the President, Council and Director of the Research Association of British Paint, Colour and Varnish Manufacturers for permission to publish this communication.

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Nature of the Catalyst in the Decomposition of Carbon Monoxide in Presence of Iron

The decomposition of carbon monoxide by the reaction, $2CO = CO_2 + C$, is catalysed in presence of iron, the maximum deposit of carbon taking place at 550° C. There is, however, no unanimity of opinion regarding the actual nature of the catalyst. Both metallic iron[1,2] and iron carbide[3,4] have been claimed to be the catalyst for the reaction.

The lack of catalytic activity of powders prepared from metallic iron in bringing about decomposition of carbon monoxide has been put forward as a strong point against the 'metal' theory. This argument does not seem to be tenable, since metallic iron is prepared at very high temperatures at which catalysts are known to lose their activities, probably due to the metal atoms finding their proper positions in the lattice. To obtain fuller information on this problem, the activities of the following materials in bringing about decomposition of carbon monoxide have been determined: (i) iron powder obtained at lower temperatures by reducing ferrous oxalate in hydrogen; (ii) iron carbide (Fe, 92·3, and C, 7·2 per cent) isolated from a sample of white cast iron (C, 3·08; Mn, 0·216; Si, 0·88; P, 0·21 and S, 0·10 per cent) by anodic dissolution in 5 per cent aqueous hydrochloric acid[5]; and (iii) iron powder obtained by reducing this carbide in hydrogen.

(i) Metallic iron obtained in a fine state of subdivision by reducing ferrous oxalate (0·1 gm.) in hydrogen at 350° C. deposited 0·12 gm. carbon when carbon monoxide was passed for two hours over the reduced material heated at 550° C.; the higher the temperature of reduction of the oxalate in hydrogen, the lower is the activity of the iron powder produced. (ii) The carbide (0·2 gm.) heated to 550° C. did not precipitate any carbon when carbon monoxide was passed over it; at this temperature maximum deposition of carbon would be expected. (iii) Reduction of this carbide (0·2 gm.) by heating it in hydrogen at 900° C. for two hours produced iron powder which catalysed the decomposition of carbon monoxide at 550° C., 0·103 gm. of carbon being deposited in two hours.

These results seem to show clearly that metallic iron is the active catalyst which brings about the decomposition of carbon monoxide.

We thank Dr. S. R. Sen Gupta, principal of the Bengal Engineering College, for his interest in this work.

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Jan. 9.

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The Monosubstituted Pteridines

The synthesis of a wide variety of monosubstituted pteridines was begun in this Department in 1949, in order to provide less complex pteridines than occur in Nature. We are using the new material to investigate the connexion between constitution and physico-chemical properties (particularly solubility, ionization constants, stability to hydrolysis, spectra). This is intended as a contribution towards relating structure to biological action.

Index of Monosubstituted Pteridines

	2	4	6	7
—OH	*a*	*a*	*b*	*b*
—OCH_3	*c*	*c*	*b*	*d*
—NH_2	*a*	*a*	*b*	*d*
—$N(CH_3)_2$	*a**	*c,e*	*b*	*d*
—NHAc	*a*	*a*†	—	*d*
—SH	*f,a*	*a*	—	*d*
—SCH_3	*d*	*d*	—	*d*
—CH_3	*d*	*d*	—	*d*
—Cl	*a*	*c*	*b*	*d*

* The 2-methylamino-analogue is also known (ref. *c*).
† 4-Hydrazinopteridine is also known (ref. *d*).

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Altogether, thirty-three new monosubstituted pteridines have been prepared. The accompanying table provides an index to the synthesis and properties of these substances, and also to the two examples discovered elsewhere. The gaps in the table, occurring in the 6-series, are attributable to the instability of intermediates.

The most stable pteridines are those with electron-releasing substituents (for example, —OH). Conversely, pteridines with substituents more electron-attracting than chlorine are expected to be highly unstable, and no examples are known having this type of substituent alone.

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Early Arrivals in Seismic Prospecting

THE conventional seismic prospecting record, showing vibrations propagated from a dynamite explosion, generally fails to yield any useful information during the first one- or two-tenths of a second after the initial onset. As a result, the study of propagation in shallow strata is for the most part limited to what can be learned from the travel-times of first arrivals. This limitation has affected the application of the seismic method to shallow prospecting problems. It also tends to hamper the experimental study of seismic propagation, since the effects of the shallower strata are often difficult to observe.

An electromechanical seismic source[1] has been developed for experimental purposes to allow more control over the generated impulse than is possible with the usual explosive source. This controlled source has proved useful in several series of experiments in underground tunnels[1,2], and has recently been tested for the first time at the surface. In these results the confusion normally found in the early part of a seismic record is absent.

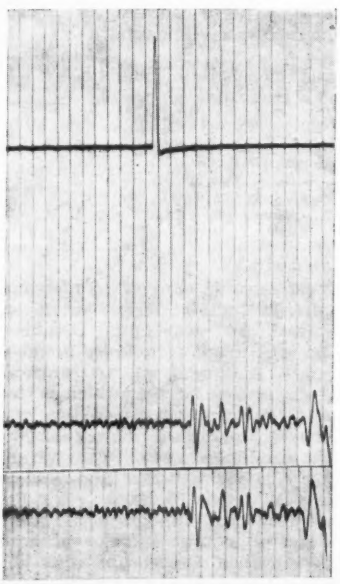

Fig. 1. Seismic record obtained with an electromechanical source, showing distinct early arrivals. A single geophone channel was used, but two records obtained in the same conditions are here juxtaposed to show the reproducibility. The top trace shows the voltage pulse applied to the source. Timing lines are at intervals of 10 m.sec. The distance from source to geophone was 125 ft.

Fig. 1 shows an example of the recorded geophone signal, containing several distinct early arrivals. Second and third arrivals may readily be distinguished within 50 m.sec. of the first, and a large fourth arrival is seen some 40 m.sec. later. Such a succession of arrivals is more reminiscent of the kind of record obtained in laboratory experiments with ultrasonic pulses. Near-surface geological conditions at the site of the observations were not unusual: sediments several hundred feet thick, having seismic velocities in the range 6,000–7,000 ft./sec., were covered by some 15 ft. of unconsolidated material, within which lay the water-table.

If the early arrivals in a seismic record can be resolved, the possibility of a shallow-reflexion technique arises. Initial onsets are normally due to direct waves or shallow refractions, which precede even the shallowest reflexions, so that in practice the standard technique seldom reveals reflecting boundaries shallower than about 400 ft. For deeper prospecting, on the other hand, the method of reflexions is steadily superseding the older refraction method.

Early arrivals have been sought in work with other unconventional sources, such as hammer-blows[3] and very small explosive charges, but with little success. Although the present electromechanical source suffers from low power and large bulk, it seems to offer a distinct advantage over other known sources for shallow seismic work. A detailed account of the experiments and an interpretation of the results will be published elsewhere.

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Feb. 9.

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Photomicrography with a Kellner Eyepiece

BELOW the lens system of a Kellner eyepiece there is a stop for supporting micrometers in the image plane, and if a small photographic plate is supported on this stop it will receive the primary image when the microscope has been correctly focused. To ensure this, a cover-slip with fine ink-markings on its under-surface is placed on the stop and adjustments made until object and markings are in focus. The lens system and cover-slip are then removed from the eyepiece and the microscope lamp switched off. Under appropriate dark-room conditions the plate is inserted emulsion downwards and protected by a light-proof cap while the exposure is being made.

The method has been found useful in preparing photomicrographs of mineral grains (Fig. 1). Using 15-mm. squares cut from lantern plates and an '*MQ*' or a caustic hydroquinone developer, sharp contrasty negatives have been obtained, sufficiently fine-grained to be enlarged fifteen times or more. For some subjects 'contact' (chloride) lantern plate was used, and with a 100-watt pearl lamp exposures were not unduly long if the magnification was small,

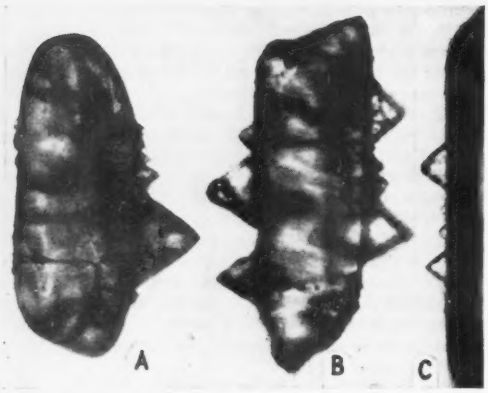

Fig. 1. Photomicrographs taken by the Kellner-eyepiece method. Outgrowths on grains of zircon. Magnifications: *A*, × 220; *B*, × 645; *C*, × 880. Objectives: *A*, × 43; *B* and *C*, × 95 oil immersion

but in general a faster (bromide) lantern plate was preferred with exposures of 1–30 sec. for 40-watt illumination. The objectives were achromatic and a tricolour blue filter between lamp and mirror appeared to improve the result.

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Bursting of Bubbles at an Air–Water Interface

In a recent communication[1], we presented a series of high-speed photographs of bursting bubbles at an air–water interface. These photographs demonstrate the manner in which small airborne droplets evolve from the vertical water jet which forms upon collapse of the bubble cavity. These studies were carried out as a contribution to the understanding of the role of bursting bubbles in the production of atmospheric sea-salt nuclei[2]. It was stated that our study was confined to bubbles of 0·2–0·02 cm. diameter. In this region the jet mechanism appears to be the only one responsible for the production of airborne nuclei. We did not imply that the production of airborne salt was entirely via the jet mechanism. For example, in a study of foam patches, it may turn out that the production of droplets is predominantly from the collapse of the bubble film[3].

The more recent communication of Knelman *et al.*[4] states "that two separate mechanisms are involved in the bursting of a bubble—one producing a cloud of droplets of diameter about 60 microns, and the other a few comparatively large drops of diameter approximately 1 mm.". Inasmuch as the authors give no reference to the size of bubble used in their work, the implication is that these two mechanisms can be applied to all cases of bubble bursting. Intuitively this is not plausible and experimentally it can be shown not to hold true. An examination of the photograph in this communication[4] indicates that the bubble is probably greater than 0·3 cm. and possibly as large as 0·6 cm. in diameter. This was determined by noting the degree to which the bubble penetrated the surface film while at rest at the surface. The larger a bubble, the larger is the ratio of the buoyant to the surface tension forces; these forces being dependent upon volume and surface respectively. This ratio can be used to provide a measure of the tendency of the bubble to rise above the surface. The bubbles studied in our work, as compared to those illustrated in the communication by Knelman *et al.*, had a much greater percentage of their volume beneath the surface. It is thus reasonable to conclude that the investigation was confined to bubbles greater than 0·3 cm. in diameter; this is further confirmed by the statement that the jet produces droplets of approximately 1 mm. diameter. This certainly would require bubbles greater than 0·3 cm. If their conclusion regarding the two separate mechanisms was based on observations of such large bubbles it would scarcely seem correct to infer that phenomena associated with these bubbles should also be found in the bursting of much smaller bubbles.

I have observed the bursting of bubbles of less than 50 microns diameter and find the jet mechanism producing droplets of 2–20 microns diameter; but can see no evidence as to any cloud produced by the bursting of a protuberance on the bubble film. If such a cloud is present, its droplets must be far less than 1 micron in diameter.

Thus we must be very cautious before we can accept any single mechanism to explain the production of airborne droplets from the bursting of bubbles. It is possible that the mechanisms proposed by Knelman *et al.* are important in the production of droplets from a collection of large bubbles in the form of a foam patch. In any event, it would be useful if Knelman and his co-workers could present more detailed information in regard to the extent of the size-range of bubbles used in their investigation. Their high-speed photography has demonstrated the existence of an interesting and possibly important phenomenon. A knowledge of the range of bubble-sizes encompassed by this mechanism has sufficient interest to warrant further investigation.

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March 17.

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Mr. Blanchard is correct in inferring that the photographs of bubble bursts accompanying the communication by Knelman, Dombrowski and Newitt (*loc. cit.*) relate to bubbles in the size range 0·3–0·6 cm. Although our experiments did not extend to the smaller sizes to which he refers, there is no reason for supposing that the two separate mechanisms disclosed in the photographs are confined to narrow size-limits; nor can we agree that "intuitively it is not plausible" for such mechanisms to operate with smaller bubbles.

We have examined photographically the break-up of thin films of a large number of liquids under conditions in which viscosity, surface tension and thickness were varied over a wide range and, in every instance, including that of mercury films, the mechanism of break up was as shown in Fig. 2 of our communication. A detailed account of this work is in course of publication.

The scale of the processes leading to the formation of drops in two size-ranges will no doubt vary with bubble-size, and it may well be difficult to measure, or even detect, drops resulting from the initial rupture of the exposed envelope of a very small bubble by conventional methods. If this is the evidence upon which Mr. Blanchard relies in support of a single-stage burst, it is indecisive. A series of photographs taken immediately prior to a burst would, on the other hand, leave no doubt as to the sequence of events.

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Light Absorption in the Crystalline Lens of the Cat

During a series of experiments in which the lenses were removed from many cats' eyes[1], the extracted material appeared colourless. The lenses remained in this condition for at least three days when stored in saline. The lenses of guinea pigs were also found to be colourless; human, cattle and pig lenses, however, are yellow in colour. A large amount of work has recently been done on the physiology of vision of the cat. In view of the filtering effect which the pre-retinal media in general, and the lens in particular, have on the visibility curve measured with the intact eye, their absorption characteristics must be known if visibility data are to be interpreted correctly. Since the cornea, aqueous and vitreous have always been observed to be colourless, attention may be focused on the lens. Accordingly, the spectral absorption characteristics of two cat lenses were measured in the range of 430–650 mμ in the same manner as described elsewhere for two human lenses[2]. The averages of both sets of data, expressed as densities, are compared in Fig. 1, where they are plotted against the wave-length. The difference in the subjective appearances of human and cat lenses is borne out by these results: the spectral variation of the absorption of the cat's lens is negligible as compared with that of man. This emphasizes inter-species differences, and throws some light on recent work.

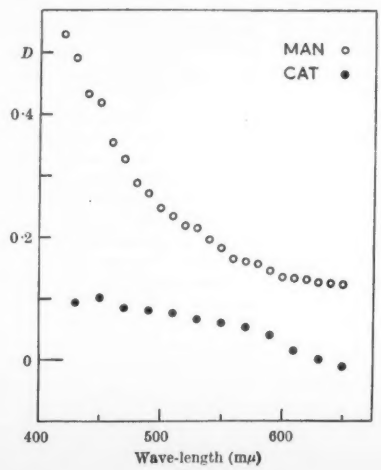

Fig. 1

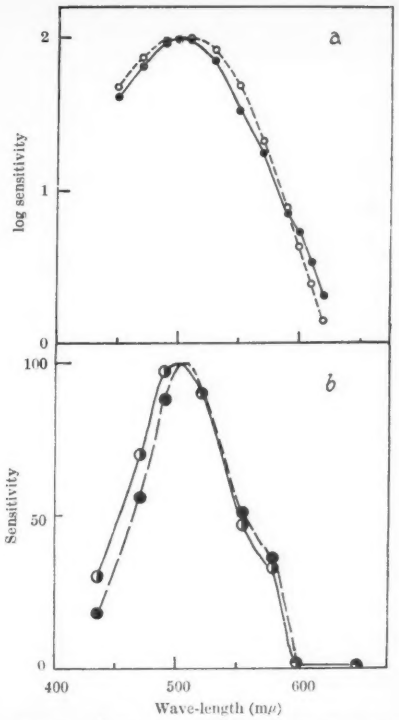

Fig. 2 *a*, ●—●, Wirth's logarithmic data for the cat, corrected for the filtering effect of the lens. O—O, Stiles and Smith's scotopic curve. *b*, ◑—◑, Visibility function expressed as a percentage of its maximum when the cattle correction is used. ●—●, the same data with the proper correction applied to them

Wirth[3] has compared spectral sensitivity data obtained from electro-retinograms on three cats with Stiles and Smith's[4] human scotopic visibility curve. Agreement between the two curves would be expected since both are thought to be based on mammalian visual purple. The correlation between them can be greatly improved in the range of 450–590 mμ by applying the appropriate lens data from Fig. 1. This is shown in Fig. 2*a*. The improvement in the agreement in the range of 450–590 mμ may be gauged from the root mean square of the difference between corresponding points. This value is 0·093 for the uncorrected, and 0·074 for the corrected, data. The corrected electro-retinogram sensitivity curve reveals a significant hump at its long wave-length end, which may be functional just as Wirth believes this to be the case in connexion with the rabbit.

The use of the wrong lens correction in cat data has led also to a misinterpretation of behavioural data. Gunter[5] used Roggenbau and Wetthauer's[6] cattle data in the belief that cattle and cat lenses had similar spectral absorptions. His scotopic visibility data for the cat agree well with Granit's[7] electrophysiological results for this animal, and also with the absorption spectrum of visual purple. This agreement, however, is spurious; when the appropriate lens correction is applied, the maximum of the visibility curve moves by about 10 mμ towards the long wave-length end of the spectrum. The effect which the proper lens correction has on the behavioural data is shown in Fig. 2*b*. This suggests

that Gunter's cats were not in a completely dark-adapted state. Since his measurements on the cat's absolute threshold[8] were done under like conditions, it is to be expected that the value which he gives is, in fact, too high. Independent support for this view is provided by a comparison of the heights of the *b*-wave and of the densities of visual purple in man and the cat.

Note added in proof. Since neither Wirth nor Gunter give any indication of the tapetal colouring, a correction for the percentage of light reflected by the tapetum cannot be applied. It is conceivable that such a correction might improve the agreement between Gunter's curve and other sensitivity data on the cat, but the residual discrepancy between Wirth's data and those of Stiles and Smith's can scarcely be explained on that basis.

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Feb. 11.

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Bacteriophage and Heredity

Many lysogenic bacteria re-adsorb the phage which they produce. Strains of *Salmonella typhi-murium* carrying phages *A*1, *A*2 and *A*5[1,2] act in this way: strains infected with phages *A*3 and *A*4 do not. Several strains infected with these types have been examined, and all have this property. Curves illustrating these facts are given in Figs. 1, 2 and 3, and show the adsorption of free phage particles when bacteria and phage particles are mixed in approximately equal numbers.

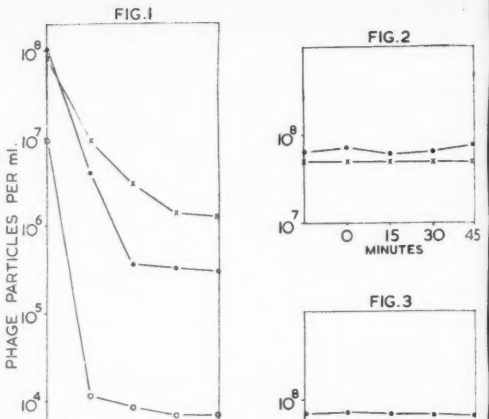
The different bacterial strains were grown overnight on nutrient agar, washed off, counted, and added to broth to give a concentration of 10^8 bacteria per ml.

Phage lysates were added in equal measured volumes to equal quantities of (*a*) broth and (*b*) the bacterial suspension. Samples were immediately taken from both (*a*) and (*b*) and heated to 58° C. for 30 min. Tube (*b*) was then incubated at 37° C. and further samples removed and heated at 15-min. intervals.

The phage content of each sample was afterwards estimated. The first point in each graph is from tube (*a*). The drop (where present) between this and the zero reading of tube (*b*) indicates the adsorption which takes place during mixing.

Bacteria symbiotically infected with phages *A*3 and *A*4 are unable to adsorb either their homologous phages or most other related types of free phage: the latter point is not shown in the graphs and need not be further considered at present.

Sensitive (uninfected) indicator bacteria (*S. typhi-murium* 1404) can be rendered lysogenic (symbiotically infected) by exposing them to a high concentration of free phage particles from a lysogenic culture[3]. Thus, a phage concentration of 10^9 particles per ml. mixed with a suspension of 10^8 bacteria per ml. (that is, a phage : bacteria ratio of 10 : 1) will render about 60 per cent of the bacteria lysogenic within 15 min. Lysogenic strains prepared in this way from phages *A*3 and *A*4, and designated 1404(*A*3) and 1404(*A*4), resemble the original lysogenic strains from which these phages were derived in that they, too, do not adsorb the phage they produce (Figs. 2 and 3). Thus, phages *A*3 and *A*4 endow the bacteria with which they enter into symbiosis not only with lysogenicity but also with the property of non-adsorption or true resistance. Both these characters are hereditary and are passed on indefinitely through subsequent generations. None of these strains—the original lysogenic strains, the indicator strain, nor the new lysogenic strains—is 'rough'.



Adsorption of homologous phage by parent lysogenic strains of *Salmonella typhi-murium*. Fig. 1. ●—●—, phage *A*1 adsorbed by type strain 1404(90*b*); ×—×—, phage *A*2 adsorbed by type strain *C*68; O—O—, phage *A*5 adsorbed by type strain *S*2/275. Fig. 2. ●—●—, phage *A*3 adsorbed by type strain 29929; ×—×—, phage *A*3 adsorbed by strain 1404(*A*3). Fig. 3. ●—●—, phage *A*4 adsorbed by type strain *S*22; ×—×—, phage *A*4 adsorbed by strain 1404/*A*4

It has been shown that adsorption of lytic phages, such as the well-known *T* series of coliphages, is influenced by external factors such as electrolyte concentration[4,5], the presence of calcium, and co-factors such as tryptophan[6], all of which can be varied at will. The essential part of the mechanism of adsorption is, however, the adhesion of the protein envelope of the particle (probably its tail[7]) to a specific 'receptor' on the bacterium. These surface receptors are related to, but not identical with, the somatic antigen of the bacterium[8]. In all cultures of bacteria sensitive to these lytic phages, occasional mutants are present which, though of normal antigenic structure, are nevertheless phage resistant, that is, do not adsorb and are unaffected by the phage. In such resistant bacteria the surface receptors are either masked or absent, due to some variation in the genetic structure of the bacterial nucleus[6].

The resistance acquired by *S. typhi-murium* when it becomes infected with phage *A*3 is functionally similar to that of bacterial mutants resistant to lytic phage, and fundamentally different from that shown to their homologous phage by bacterial strains sym-

biotically infected with, say, phage *A*1. In the latter, the free phage is adsorbed but is 'liquidated' without undergoing further development, possibly because it is denied access to some essential structure or location in the bacterium which is already monopolized by the symbiotic particle. The uninfected indicator organism readily adsorbs phage *A*3. The inability of the same organism to do so when symbiotically infected with this phage must, as in the case of the mutant which refuses the lytic phage, be attributable to some change in the receptor mechanism, possibly a masking or elimination of the surface receptors. As this change is permanent and hereditary, it also would appear to be associated with some modification of the genetic apparatus of the organism.

The work of Lederberg and his colleagues[9–11] has shown that bacterial genes can be transduced from one bacterium to another through the agency of symbiotic phage, creating in this way rare mutants possessing some biochemical or other property not found in the 'recipient' organism. In the phenomenon now described, the position is very different. The property of resistance is not transduced occasionally from one bacterium to another, but is found in every organism infected by the symbiotic phage. This provides further evidence of the close relationship of phage particle and bacterial nucleus, and suggests that the phage either eliminates or in some way blocks the gene which controls receptor formation. It appears to be an example on a large scale of what Lederberg[9] calls "extranuclear heredity", producing a race of bacteria with the characters of mutants.

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Feb. 22.

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Different-sized Infective Particles of Rift Valley Fever Virus

In a recent communication, Polson[1] indicated that the small animal viruses fall into definite weight-groups as calculated from their sedimentation constants, using the usual assumptions regarding density and particle shape. The particle weights are multiples of 1, 4, 16 and 64 of a basic unit, 12 mμ in diameter. Soluble antigen which itself is non-infective has been recovered from tissues infected with a variety of virus. It is of particular interest that those soluble antigens which have been measured are all approximately 12 mμ in diameter (influenza[2], rabies[3] and African horsesickness virus[4]).

More recently, it has been found[4] that some of the small viruses show at least two infective particles of different size, the smaller being approximately a quarter of the particle weight of the larger component. The work reported here is that carried out on different

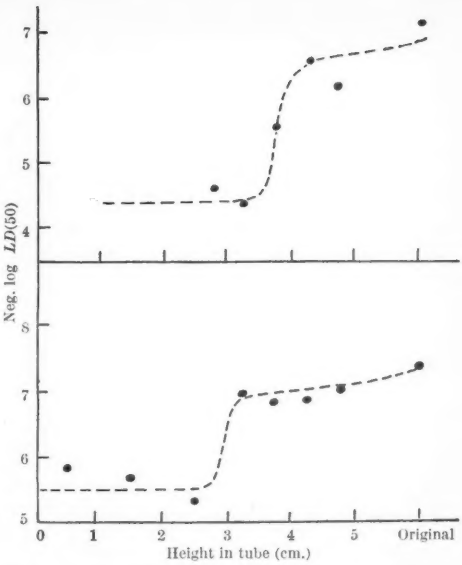

Fig. 1. Virus concentration at various levels in the centrifuge tube in two typical experiments with viscerotropic rift valley fever centrifuged at 11,000 r.p.m. for 100 min.

forms of rift valley fever virus. Particle sizes were determined by the ultracentrifugation technique described by Polson and Linder[5].

Viscerotropic rift valley fever virus. Defibrinated blood from mice 24–48 hr. after intraperitoneal infection with viscerotropic rift valley fever virus was ultracentrifuged at 11,000 r.p.m. for 100 min. in a hæmocyanine gradient[5] in a Spinco model *L* centrifuge. The meniscus of the fluid was 5·32 cm. from the centre of rotation. Samples taken at different levels were titrated by intraperitoneal inoculation of mice. From five different experiments an average sedimentation constant of 452 Svedberg units was obtained giving a particle size of 49·7 mμ. These experiments show the presence of only one infective form, as is evident from the sedimentation diagrams in Fig. 1.

Neurotropic rift valley fever virus. This form of the virus had been passaged intracerebrally 106 times in mice, followed by fifty passages in chick embryos and a further nine intracerebral passages in mice. A 10 per cent suspension of infected mouse brain in 10 per cent rabbit serum saline was ultracentrifuged under identical conditions used for the viscerotropic form of this virus. Samples taken at different levels were titrated by intracerebral inoculation of mice. A typical sedimentation diagram (Fig. 2) shows two components with sedimentation constants of 175 and 492 Svedberg units respectively, giving particle sizes of 30·9 mμ and 51·8 mμ. These results are similar to those found in the case of neurotropic horse-sickness virus[2]. Recent unpublished results obtained in collaboration with Dr. Alexander (Onderstepoort Laboratories) have shown that neurotropic rift valley fever virus, which had been passaged through 102 generations of mice without any further passages in embryonated eggs, contains the 50-mμ particle. The 30-mμ particle could not be detected in this material. These results indicate that the difference described in this communication between the viscerotropic and

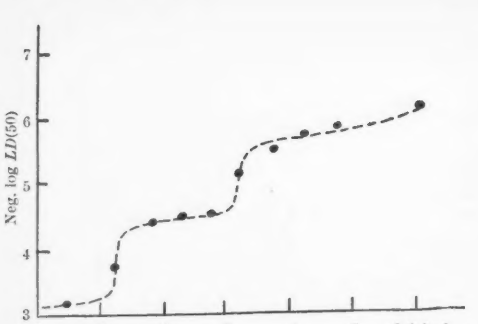

Fig. 2. Virus concentration at various levels in the centrifuge tube in a typical experiment with neurotropic rift valley fever centrifuged at 11,000 r.p.m. for 100 min.

neurotropic (106 mice, 50 egg and 9 mice) forms is not due to the difference in composition of the media in which the viruses were suspended. The difference between the particle sizes of the viscerotropic form and the larger neurotropic form is probably not significant as it lies within the bounds of experimental error of the method.

It is of interest that the 'light' particle in neurotropic rift valley fever is very similar in size to those in the second group described in the size classification in a previous communication[1], and it is additional support of the concept that the smaller animal viruses are built up as aggregates of particles 12 mμ in diameter.

We wish to thank Prof. M. van den Ende for his interest in this work, and the Director of Onderstepoort Laboratories, Dr. R. A. Alexander, for supplying the virus investigated.

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W. du T. Naudé
T. Madsen
A. Polson

South African Council for Scientific and Industrial Research, and the University of Cape Town Virus Research Unit, Department of Pathology, University of Cape Town.
Jan. 25.

[1] Polson, A., *Nature*, **172**, 1154 (1953).
[2] Hoyle, L., Reed, R., and Astbury, W. T., *Nature*, **171**, 256 (1953).
[3] Polson, A., and Wessels, P. O., *Proc. Soc. Exp. Biol. and Med.*, **84**, 317 (1953).
[4] Polson, A., and Madsen, T. (to be published).
[5] Polson, A., and Linder, A. M., *Biochim. et Biophys. Acta*, **11**, 199 (1953).

Control of Cockchafer Grubs by Seed Treatment

In the Sudan Gezira, cockchafer grubs (white grubs) of the genus *Schizonycha* (Melolonthinae) can attack the young roots of sorghum (*Sorghum vulgare* Pers.), causing wilting, stunting and death with attendant poor stands and considerably reduced yields. Older plants with established root systems are less commonly killed, although it is likely that the grubs feed on the roots. Use of powder seed-dressings containing fungicide (thiram or organo-mercurial) and 20–40 per cent by weight of gamma benzene hexachloride (BHC) gave almost complete protection of sorghum seedlings from these pests. In field-plot experiments, BHC-treated seed invariably gave 90–100 per cent stand, whereas fungicide-treated seed gave poor stands of 50–60 per cent in many cases. By 'percentage stand' is here meant the percentage of good holes to total holes sown. In some plots BHC seed-treatment resulted in 20–30 per cent increases of grain and straw yields.

Wilting and death of seedlings commenced soon after emergence from the soil, and in some experiments continued for several weeks, reaching maximum incidence 10–21 days after sowing. Month-old plants had usually developed sufficiently extensive root systems to withstand fatal attack. The significance of the BHC lies in the protection it affords to the seedling and young plant up to the time when adequate roots have developed. The seed dressings were used at the application rate of 1 gm. per lb. of seed, with seed-rate of 10 lb. or less per acre, giving the remarkably small dosage of about 2 gm. of BHC per acre in the case of 20 per cent BHC dressings. The insecticide was, however, all concentrated in the immediate vicinity of the seed. Cockchafer grubs were found near the roots of plants grown from both fungicide and fungicide – BHC-treated seed; in the former case roots were attacked, but in the latter no attack was evident and the grubs tended to be somewhat smaller. No doubt the BHC, although not killing the grubs, repels them from the seedlings.

In small-scale experiments similar effects were noted with maize (*Zea mays* L.) and the wild *Sorghum purpureo-sericeum* Aschers. and Schweinf. Cockchafer grubs also attack groundnuts (*Arachis hypogaea* L.) and dolichos bean (*Dolichos lablab* L.), but there is little evidence that seed treatment with BHC protects these plants. There may be several reasons for this. In them the seed bearing the insecticide is carried above ground during germination, whereas in sorghum it remains in the soil. Dolichos and groundnut tend to have more or less well-developed tap roots, a system of rooting probably more vulnerable to grub attack than the profuse development of surface adventitious roots characteristic of sorghum; in support of this is the observation that groundnut and dolichos plants may be attacked and destroyed by grubs a month or more after sowing, whereas sorghum plants of that age rarely succumb. In field-trials, dressings containing 40 per cent BHC were slightly phytotoxic to sorghum when used at 1 gm. per lb. of seed. Pot experiments indicated that 0·08 per cent BHC/seed had an appreciable adverse effect, but not 0·04 per cent.

Similar markedly improved stands and increased yields have followed the use of combined fungicide – BHC seed dressings on rain-grown sorghum in the Central Rainlands area south of the Gezira. Here, however, it is likely that, in some cases at least, the BHC affords protection against small ants (*Pheidole rugaticeps* Em.) which consume and carry away untreated seed.

Since this method promises to be a simple, effective and inexpensive way of protecting sorghum and possibly other grass seedlings from cockchafer grubs and certain other soil pests, this preliminary communication may be of use in countries where these insects cause damage. A fuller account will be published in due course.

S. A. J. Tarr

Section of Botany and Plant Pathology, The Gezira Research Farm, Wad Medani, Sudan.
Jan. 30.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, May 31

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 2.30 p.m.—Annual General Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. R. Williamson: "The Germ Theory of Disease. Neglected Precursors of Louis Pasteur (Richard Bradley, Benjamin Marten, Jean-Baptiste Goiffon)".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Sir Harry Luke: "Easter Island".

Monday, May 31—Thursday, June 3

INSTITUTION OF GAS ENGINEERS (in the Winter Gardens, Bournemouth).—91st Annual General Meeting.

Tuesday, June 1

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Prof. M. E. L. Mallowan: "Recent Work in Archæology outside Europe". (4) "Iraq".*

Tuesday, June 1—Friday, June 4

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at Brussels).—Joint Conference with the ASSOCIATION BELGE POUR L'ÉTUDE, L'ESSAI ET L'EMPLOI DES MATÉRIAUX (A.B.E.M.).

Wednesday, June 2

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. B. C. King: "The Ard Bheinn Area of the Central Igneous Complex of Arran"; Miss Suzanne L. Duigan and others: "Plant Remains from the Gravels of the Summertown-Radley Terrace, near Dorchester, Oxfordshire".

Thursday, June 3

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: Claude Silbert Hudson Memorial Lecture.

Friday, June 4

INSTITUTE OF NAVIGATION (joint meeting with the ROYAL GEOGRAPHICAL SOCIETY, at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Bruno Vailati: "Exploring the Ocean Bed".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Arthur H. Compton: "Science and Man's Unfolding View of Himself".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL SCIENTIFIC OFFICERS (2) (with a university degree of high standard in science or engineering or equivalent qualifications, and extensive experience in aerodynamics research, especially in the transonic or supersonic fields, and experience in directing a team of research workers) IN THE HIGH SPEED AERODYNAMICS LABORATORY, Department of Supply, Salisbury, South Australia, for (*a*) to be responsible for experimental research, both basic and applied, into the aerodynamics of high-speed aircraft and missiles using the rocket-boosted free flight model technique (Ref. Position No. 352), and (*b*) to be responsible for experimental research work, both basic and applied, into problems of supersonic flow using wind tunnels, stock tubes and similar apparatus (Ref. Position No. 328)—The Senior Representative (A.P. 15), Department of Supply, Australia House, Strand, London, W.C.2 (June 4), quoting appropriate Ref. No.

SENIOR EXPERIMENTAL OFFICER (with a degree or diploma of a recognized University or Technical College, or equivalent qualifications, and preferably with a knowledge of aircraft control) AT THE LONG RANGE WEAPONS ESTABLISHMENT, Salisbury, South Australia, to be responsible for the execution of an extensive programme of air to air and air to ground trials, and the co-ordination of electronic and optical instrumentation, piloted and pilotless aircraft and requirements specified by contractors—The Senior Representative (A.P. 16), Department of Supply, Australia House, Strand, London, W.C.2 (June 4).

ASSISTANT LECTURER or LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY, and a RESEARCH ASSISTANT IN INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 5).

LECTURER (preferably with experience in nuclear magnetic resonance) IN PHYSICS—The Secretary and Registrar, University College of North Wales, Bangor (June 7).

SENIOR EXPERIMENTAL OFFICER (with a pass degree in engineering or higher national certificate, or equivalent or higher qualifications, and preferably with experience in design, operation and maintenance of mechanical and electrical plant), IN THE MECHANICAL ENGINEERING RESEARCH LABORATORY, Department of Scientific and Industrial Research, East Kilbride, near Glasgow, for design and development work on specialized test plant and control gear for a new hydraulics machinery laboratory, undertaking research on pumps, turbines and associated equipment—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4327/54 (June 10).

ASSISTANT IN MATHEMATICS—The Secretary of University Court, The University, Glasgow (June 12).

ASSISTANT LECTURER (with qualifications in mathematics, but interested mainly in economics and social science) IN THE DEPARTMENTS OF MATHEMATICS AND ECONOMICS—The Secretary to the Trustees, Magee University College, Londonderry, Northern Ireland (June 12).

ELECTRICAL or MECHANICAL ENGINEER (with first- or second-class honours degree or equivalent in electrical or mechanical engineering, and preferably with experience of design of control gear and knowledge of hydraulics), at Ministry of Supply Establishment, near Sevenoaks, Kent, for design and development of hydraulic and electrical equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.312/54A (June 12).

SENIOR RESEARCH STUDENT IN ENGINEERING—The Registrar, University College, Singleton Park, Swansea (June 14).

CHEMICAL ENGINEER (Principal Scientific Officer) (with a first- or second-class honours degree with high qualifications and research experience in chemical engineering), AT THE CHEMICAL RESEARCH LABORATORY, Department of Scientific and Industrial Research, Teddington, to initiate research in chemical engineering and to build up and lead a team of research workers in this subject—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4332/54 (June 17).

HEAD OF THE POMOLOGY DEPARTMENT, to supervise research in fruit breeding—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (June 18).

ASSISTANT LECTURER (with special qualifications in physical geography) IN GEOGRAPHY—The Registrar, Trinity College, Dublin (June 19).

LECTURER IN GEOGRAPHY METHOD IN THE FACULTY OF EDUCATION, Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 19).

ZOOLOGIST (graduate in zoology of a British university) at the Dove Marine Laboratory—The Registrar, King's College, Newcastle upon Tyne (June 19).

RESEARCH FELLOW (with an honours degree in chemistry or agricultural chemistry, and experience in the chemistry of soils) IN SOIL CHEMISTRY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 20).

ASSISTANT LECTURER, Grade III, or LECTURER, Grade II (with veterinary or zoological qualifications), IN EMBRYOLOGY—The Registrar and Secretary, The University, Bristol (June 21).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Leeds 2 (June 21).

LECTURER or ASSISTANT LECTURER (with a special interest in endocrinology or pharmacology) IN PHYSIOLOGY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (June 23).

RESEARCH OFFICER (Chemist or Biochemist) (with a university honours degree in science, with chemistry, botany or biochemistry as major subjects, and preferably with some research experience in mycology) IN THE WOOL TEXTILE RESEARCH LABORATORIES, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, Australia, to take part in a programme of research on cellulose-destroying fungi, with special reference to the nutritional requirements of particular moulds, the nature of the enzymes produced and their mode of action on cellulose—The Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 462/69 (June 26).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with an honours degree in science, and advanced training or experience in physical chemistry, and a bias towards research in the field of inorganic chemistry) IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Melbourne, Victoria, Australia, to investigate physicochemical problems related to the fundamental and applied chemistry of mineral derivatives (Ref. 590/489); also a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with an honours degree in science, with chemistry as a major subject or equivalent qualifications, and with post-graduate experience in some branch of electrochemistry), to undertake physicochemical studies of inorganic systems, particularly those of importance in the electrochemical processing of minerals and their derivatives (Ref. 590/460)—The Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (June 26).

BIOCHEMISTRY GRADUATE (Ph.D. or equivalent experience) to carry out investigations on enzymes involved in intracellular amino-acid and protein metabolism in red cells—The Regional Director, Blood Transfusion Service, Royal Infirmary, Edinburgh (June 30).

LECTURER (with an honours degree in mechanical engineering, and preferably with special experience in mechanical engineering drawing and design, theory of machines and strength of materials) IN MECHANICAL ENGINEERING, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, June 30).

LECTURERS (with a degree or equivalent qualification) in (*a*) Crop Production (Plant Breeding), (*b*) Animal Production, (*c*) Animal Health, and (*d*) Agricultural Engineering, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 30).

SENIOR LECTURER IN SOIL SCIENCE in the Faculty of Agriculture, University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, June 30).

SENIOR LECTURER (with a higher degree or equivalent qualification in physics, and lecturing experience) IN PHYSICS, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 17).

ASSISTANT BIOLOGIST (preferably with a degree in microbiology, or botany with chemistry) for mycological work on the deterioration of paper products—Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.

CHEMICAL ENGINEER (with first- or second-class honours degree in chemical engineering, or in chemistry with a diploma in chemical engineering, or A.M.I.Chem.E., together with four years postgraduate experience in chemical engineering) for design and development work on various types of chemical plant in the radioactive and inorganic field—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 145/W.G.E./2.

COUNTY LECTURER (with a degree or diploma in agriculture and sound practical farming experience) IN AGRICULTURE, to assist in the organization and administration of agricultural education in the County of Derbyshire—The Principal, Derbyshire County Farm Institute, Broomfield Hall, Morley, near Derby.

DEMONSTRATOR IN ELECTRICAL ENGINEERING—Prof. G. F. Tracy, Electrical Building, University of Toronto, Toronto 5, Canada.

EXPERIMENTAL OFFICERS OR ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. (science), and preferably with experience in the handling of explosives, together with some knowledge of electronics), AT THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, Fort Halsted, Kent, to carry out work on explosion effects and to perform experimental physical research using small-scale explosive charges and high-speed recording equipment—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire quoting 60/W.G.E./34.

PHYSICIST (preferably with some experience in hospital physics), to work on the clinical applications of the 8 MeV. Linear Accelerator, including the dosimetry of the X-ray and electron beams—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

SCIENTIFIC OFFICER (with at least a good second-class honours degree in chemistry or biochemistry, and not less than two years postgraduate experience) AT THE WEST AFRICAN FISHERIES RESEARCH STATION, for hydrological research and part-time biochemical studies on the preservation of fish and the associated degenerative studies—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.197/194/01.

SENIOR LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

SENIOR SCIENTIFIC OFFICERS (with at least a second-class honours degree, and three years postgraduate research experience in physical or organic chemistry), to take charge of sections engaged on investigations associated with the extraction and preparation of rare metals and their compounds, using techniques of solution chemistry, ion exchange and vapour phase reactions involving metals and volatile metal compounds; and study of reaction kinetics and high temperatures and gas/solid reactions—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 590.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement

Great Britain and Ireland

Handbook for Museum Curators. Part B, Section 4 (Museum Technique): The Application of X-Rays, Gamma Rays, Ultra-Violet Rays to the Study of Antiques. By Dr. A. A. Moss. Pp. 16. (London: Museums Association, 1954.) 4*s*. (3*s*. to members). [173

Department of Scientific and Industrial Research. Report for the year 1952–53. Pp. 315. (Cmd. 9083.) (London: H.M. Stationery Office, 1954.) 8*s*. net. [183

University of Birmingham. Calendar for the Session 1953–1954. Pp. xxix+412. (Birmingham: Cornish Brothers, 1953.) 5*s*. [223

Lundy Field Society. Seventh Annual Report, 1953. Pp. 56+3 plates. (Exeter: Lundy Field Society, L. A. Harvey, Esq., University College, 1954.) 2*s*. 6*d*. [223

National Smoke Abatement Society. Proceedings of the 20th Annual Conference, Glasgow, 30th September to 2nd October, 1953. Pp. 100. (London: National Smoke Abatement Society, 1954.) 7*s*. 6*d*. [223

Rituals of Rebellion in South-East Africa. By Prof. Max Gluckman. (The Frazer Lecture, 1952.) Pp. ii+36. (Manchester: Manchester University Press, 1954.) 3*s*. 6*d*. [223

British Institute of Management. Report of the Annual Conference, Harrogate, 1953. Pp. 208. (London: British Institute of Management, 1954.) 7*s*. 6*d*. [223

Handbook of Scientific Instruments and Apparatus, 1954. (Published in connection with the 38th Physical Society Exhibition.) Pp. xvi+202+76. (London: Physical Society, 1954.) [223

Royal Technical College, Glasgow. Annual Report on the One Hundred and Fifty-Seventh Session (1952–1953). Pp. 96. (Glasgow: Royal Technical College, 1953.) [223

Bird Study. Vol. 1, No. 1 (March 1954). Pp. ii+36. (Oxford: British Trust for Ornithology, 1954.) 5*s*. [223

Association of Agriculture. Annual Report for 1953. Pp. 8. (London: Association of Agriculture, 1954.) [223

Aero Research Technical Notes. Bulletin No. 134: Resorcinol-Formaldehyde Adhesives: Some Notes on the Properties and Uses of "Aerodux" 185. Pp. 6. (Duxford: Aero Research, Ltd., 1954.) [223

The Scientific Journal of the Royal College of Science. Vol. 23: Containing papers read before the Imperial College Chemical Society, the Royal College of Science Natural History Society, the Royal College of Science Mathematical and Physical Society. Pp. vi+114. (London: Royal College of Science, 1953.) 10*s*. 6*d*. [223

Silicones for Use in Medicine. Pp. 16. (Chadwell Heath: Hopkin and Williams, Ltd., and Midland Silicones, Ltd., 1953.) [223

Association of British Chemical Manufacturers. Report on the Chemical Industry, 1953; a Supplement to the 1949 Report. Pp. 12. (London: Association of British Chemical Manufacturers, 1954.) 1*s*. [243

Geographical Studies. Vol. 1, No. 1, 1954. Pp. ii+86. (London: Birkbeck College, 1954.) [243

The Place of Botany in the Life of a University. By Prof. C. D. Darlington. (An Inaugural Lecture dellvered before the University of Oxford on 27 November 1953.) Pp. 24. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 2*s*. 6*d*. net. [243

Other Countries

Bulletin of the Central Electrochemical Research Institute, Karaikudi. Vol. 1, No. 1 (January 1954.) Pp. 46. (Karaikudi: Central Electrochemical Research Institute, 1954.) [223

U.S. Department of Commerce: National Bureau of Standards. Handbook No. 53: Recommendations for the Disposal of Carbon-14 Wastes. Pp. vi+14. (Washington, D.C.: Government Printing Office, 1953.) 15 cents. [223

Seed Production Testing and Distribution in European Countries. (Technical Assistance Mission No. 106.) Pp. 188. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 10*s*.; 500 francs. [223

Province of Quebec. Department of Mines—Laboratories Branch. P.R. No. 281: A Chemical Study of the Peats of Quebec. 2: The Lac-à-la Tortue Bog, Laviolette County. By J. Risi, C. E. Brunette, D. Spence and H. Girard. P.R. No. 282: A Chemical Study of the Peats of Quebec. 3: The Lanoraie Bog, Berthier and Joliette Counties. 4: The Farnham Bog, Missisquoi and Iberville Counties. 5: The Rivière-du-Loup Bog, Rivière-du-Loup County. By J. Risi, C. E. Brunette, D. Spence and H. Girard. Pp. iv+40. (Quebec: Department of Mines, 1953.) [223

Mitteilungen der Hamburger Sternwarte in Bergedorf. Band 9. Nr. 79: Ein dreilinsiges Objektiv für die photographische Photometrie. Von P. Wellmann. Nr. 80: Photographische Photometrie des Sternhaufens Coma Berenices in drie Spektralbereichen mit einem photometrischen Spezialobjektiv. Von J. Stock. Pp. 91–116. Nr. 82: Dynamische Begründung der Geschwindigkeitsverteilung in Sternsystem. Von W. Fricke. Pp. 125–148. Nr. 83: Der Lichtwechsel des langperiodischen β Lyrae-Sterns BM Cassiopeiae. Von Max Beyer. Nr. 84: Visuelle Helligkeitsbeobachtungen von Neuen Sternen. Von Max Beyer. Pp. 149–164. Nr. 85: Untersuchungen an Zeitbestimmungen. Von Joh. V. D. Heide. Pp. 165–172. Nr. 86: Die Schwärzungsabhängigkeit der isophoten Wellenlänge bei chromatischen Objektiven. Von J. Stock. Pp. 172–176. Nr. 87: Der Lichtwechsel und die Lage der Rotationsachse des Planeten 433 Eros während der Opposition 1951–52. Von Max Beyer. Pp. 177–186. (Bergedorf: Im Verlag der Sternwarte 1952 and 1953.) [223

Hamburger Sternwarte in Bergedorf. Bergedorfer Spektral-Durchmusterung der 115 nördlichen Kapteynschen Eichfelder, enthaltend für die Sterne bis zur 13. photographischen Grosse, die Spektren nach Aufnahmen mit dem Lippert-Astrographen der Hamburger Sternwarte in Bergedorf. Von A. Schwassmann. Die Grössen nach Aufnahmen des Harvard College Observatory bestimmt durch das Sterrenkundig Laboratorium Kapteyn in Gronningen. Von P. J. van Rhijn, unter mitwirkung von L. Plaut. Pp. 296. (Bergedorf: Im Verlag der Sternwarte, 1953.) [223

Zweiter Katalog der Astronomischen Gesellschaft für das Aquinoktium, 1950. Örter der Sterne bis zur neunten Grösse swischen dem Nordpol und 2° südlicher Deklination abgeleitet aus photographischen Himmelsaufnahmen der Sternwarten Bergedorf und Bonn, unter Leitung von Richard Schorr und Arnold Kohlschütter. Fünter Band: Deklination +45° bis +50°. Pp. iv+240. Sechster Band: Deklination +40° bis +45°. Pp. iv+258. Siebenter Band: Deklination +35° bis 40°. Pp. iv+266. Achter Band: Deklination +30° bis +35°. Pp. iv+266. Neunter Band: Deklination +25° bis +30°. Pp. iv+308. (Hamburg-Bergedorf: Verlag der Sternwarte, 1952 and 1953.) [223

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1951. Pp. 12. Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1952. Pp. 8. (Hamburg-Bergedorf: Verlag der Sternwarte, 1952 and 1953.) [223

U.S. Department of Agriculture. Farmers' Bulletin No. 1531: The Tobacco Budworm and Its Control. Pp. 8. (Washington, D.C.: Government Printing Office, 1953.) 5 cents. [223

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 34, No. 25: Notes on Several Lizards of the Genus *Emoia*, with descriptions of new species from the Solomon Islands. By Walter C. Brown. Pp. 263–276. (Chicago: Chicago Natural History Museum, 1954.) 50 cents.

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